DOI:
10.1016/j.jpain.2023.07.030

Document Version
Publisher's PDF, also known as Version of record

USASP
US ASSOCIATION FOR THE STUDY OF PAIN

PUBLISHED BY
ELSEVIER

The Journal of Pain, Vol xxx, No. xx (Month),xxxx: pp xxx–xxx
Available online at www.jpain.org and www.sciencedirect.com

Original Reports

Body Mindsets are Associated With Pain and Threat-Related Risk Factors for Pain in Survivors of Childhood Cancer

Emily J. Dowling,[*] Laura E. Simons,[†] Alia J. Crum,[‡] Sheri L. Spunt,[§] Pamela Simon,[§] Sarah N. Webster,[†] Matthew R.D. Brown,[¶,‖] Shaman Jhanji,[¶,‖] Joseph Chilcot,[*] and Lauren C. Heathcote[*]

[*]*Health Psychology Section, Department of Psychology, Institute of Psychiatry, Psychology and Neuroscience, King's College London, United Kingdom,* [†]*Department of Anesthesiology, Perioperative, and Pain Medicine, Stanford University School of Medicine, Stanford, California,* [‡]*Department of Psychology, Stanford University, Stanford, California,* [§]*Division of Hematology/Oncology, Department of Pediatrics, Stanford University School of Medicine, Stanford, California,* [¶]*Anaesthetics, Perioperative Medicine and Pain Department, The Royal Marsden NHS Foundation Trust, London, United Kingdom,* [‖]*Pain Management Team, The Royal Marsden Hospital, The Institute of Cancer Research, London, United Kingdom*

Abstract: **Pain is a common consequence of childhood cancer. While most research has examined biomedical predictors of post-cancer pain, biopsychosocial conceptualisations such as the cancer threat interpretation (CTI) model hold promise for guiding comprehensive pain management strategies. Guided by the CTI model, this cross-sectional study evaluated correlates of post-cancer pain in childhood cancer survivors including threat-related risk factors (bodily threat monitoring, fear of cancer recurrence, help-seeking) and mindsets about the body. In the preceding three months, 21.8% of the survivors reported chronic pain (> 3 months), and 14.3% experienced pain most days. Greater bodily threat monitoring, more fear of cancer recurrence, and more help-seeking were associated with more pain. There was heterogeneity in the mindsets that survivors of childhood cancer hold about their bodies. Holding the mindset that the 'body is an adversary' was associated with more pain, greater bodily threat monitoring, and more fear of cancer recurrence. Holding the mindset that the 'body is responsive' was associated with less bodily threat monitoring, while the mindset that the 'body is capable' was associated with greater help-seeking. A path model demonstrated a significant combined indirect effect of the 'body is an adversary' mindset on pain through bodily threat monitoring and fear of cancer recurrence. Overall, this study supported that a sub-group of childhood cancer survivors experience persistent and interfering pain and provided cross-sectional support for threat-related correlates for pain aligning with the CTI model. Body mindsets were associated with pain and threat-related correlates and may represent a novel target to support survivors with pain.**

Perspective: ***This article presents associations of body mindsets, threat-related risk factors, and pain in survivors of childhood cancer (aged 11–25), guided by the Cancer Threat Interpretation model. The study indicates that body mindsets may be novel targets to embed in comprehensive post-cancer pain management approaches to support young survivors with pain.***

Received April 20, 2023; Received in revised form June 28, 2023; Accepted July 29, 2023
This research was funded by Stanford University, School of Medicine, Department of Anaesthesiology, Perioperative and Pain Management to develop the Bodily Threat Monitoring Scale. No conflicts of interest to declare.
Supplementary data accompanying this article are available online at www.jpain.org and www.sciencedirect.com

Address reprint requests to Lauren C. Heathcote, Guy's Hospital, 5th Floor Bermondsey Wing, Great Maze Pond, London SE19RT, UK. E-mail: lcheath@stanford.edu
1526-5900/$36.00

https://doi.org/10.1016/j.jpain.2023.07.030

Key words: *Childhood cancer survivors, Pain, Fear of cancer recurrence, Bodily threat monitoring, Body mindsets*

Due to continuing medical advances, five-year survival rates from paediatric cancer have increased to 83%, along with a 66% reduction in mortality.[1] Pain, including chronic pain, is a common symptom of cancer survival, with a subset of survivors experiencing persistent, frequent, and interfering pain.[2–4] Survivors of childhood cancer who report long-term pain experience impairment in psychological well-being[3] and health-related quality of life.[4,5] Survivors aged 11 to 25 must navigate major developmental milestones and cope with the transition to adult healthcare. The experience and impact of pain require examination within these unique developmental contexts.[6] Identifying risk factors for post-cancer pain is a research priority to guide evidenced based pain management approaches for this in-need population.[7,8]

Research on pain in cancer survivors has largely focused on biomedical risk factors.[8,9] Being female[10] and a previous diagnosis of bone and soft tissue sarcoma[11] are risk factors for pain in long-term survivors of childhood cancer. More recently, biopsychosocial conceptualisations of post-cancer pain have emerged, and hold promise for guiding comprehensive pain management strategies.[12,13] In previous studies, greater pain catastrophising, post-traumatic stress, and anxious and depressive symptoms were shown to be associated with chronic pain in childhood cancer survivors.[2] The cancer threat interpretation (CTI) model[14] places the experience of post-cancer pain within the broader context of survival-related uncertainty. Per the CTI model, cancer survivors inhabit an environment of symptom uncertainty which can make the experience of pain a cue of threat, promoting fear of disease recurrence,[3,11] bodily threat monitoring, and help-seeking behaviours.[14] Yet, few studies have examined the cognitive style of bodily threat monitoring in cancer survivors, which is proposed to instigate the cycle of amplified pain and fear. The behavioural consequences of this cycle, particularly help-seeking, have also been neglected.

The CTI model places pain within the broader experience of survival-related uncertainty and calls for an understanding of how uncertainty impacts the experience of post-cancer pain. Growing research recognises that mindsets—core associations about the nature and workings of things in the world—are important for shaping how we make sense of and respond to uncertainty.[15–18] Mindsets are neither true nor false, but enable us to make sense of an uncertain world through a selective lens that influences attention, affect, and behaviour.[19] A salient experience of health-related uncertainty commencing at cancer diagnosis and continuing into treatment could shape the mindsets that young individuals hold about their bodies.[20] Mindsets about the body may guide survivors in making sense of and responding to pain. For example, a cancer diagnosis could evoke the mindset that the body is an untrustworthy adversary, promoting fear and bodily threat monitoring, further amplifying pain, as well as excessive reassurance-seeking or avoidance.[20] In contrast, mindsets that the body is capable of recovering and healing after successful oncological management could decrease bodily threat monitoring and fear, lessening the experience of pain.[21] To date, no studies have investigated body mindsets in childhood cancer survivors and how mindsets relate to the experience and impact of post-cancer pain.

This study had three aims. Firstly, to describe pain characteristics, including chronic pain, in a sample of survivors of childhood cancer (aged 11–25). Secondly, we aimed to investigate the mindsets that these survivors hold about their bodies. Thirdly, we aimed to explore associations of pain characteristics, body mindsets, and threat-related risk factors as proposed in the CTI model. Our specific hypotheses stemmed from the CTI model in that bodily threat monitoring, fear of cancer recurrence, and help-seeking would be associated with worse pain experiences.

Methods

Participants

Individuals were eligible to participate if they were aged 11 to 25 years, had previously received a paediatric cancer diagnosis of any type (diagnosis ≤18 years), were not currently receiving active cancer treatment, and were proficient in English. Potential participants were excluded if they had significant cognitive impairment, as assessed via medical records or clinician or parent reports. Significant cognitive impairment was defined as any cognitive impairment that could prevent understanding and completion of the study measures.

Recruitment

Ethical approval was obtained by the Stanford Medicine Institutional Review Board (IRB-44463). Survivors of childhood cancer were recruited via convenience sampling from the Bass Childhood Centre for Childhood Cancer and Blood Diseases at Lucile Packard Children's Hospital from November 2019 through March 2021. Participants were identified through screening medical records for patients who had completed treatment and were attending short- or long-term follow-up appointments as part of their routine survivorship care. Parents and patients were sent letters and emails about the research study and were contacted by telephone to gauge interest in participating. Caregivers provided consent for survivors who were under the age of 18 and survivors provided consent (if 18 or over) or assent (if under 18). Participants were required to be fluent in

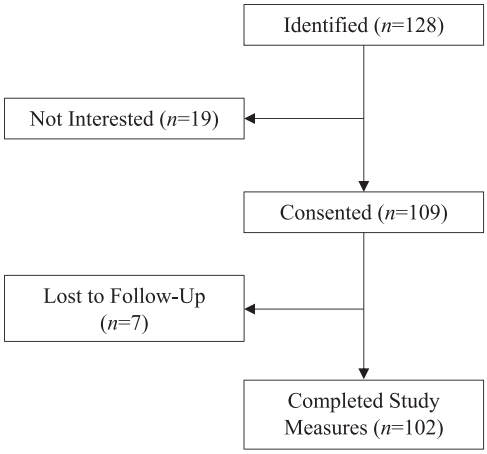

Figure 1. Participant flowchart.

English, but a Spanish language information sheet and consent form was provided for Spanish-speaking parents. Of the 128 survivors who were identified, 102 survivors consented and took part in the study indicating a recruitment rate of 80% (see Fig 1). Eligible participants were sent a link to complete questionnaires online via REDCap, a secure data acquisition system.[22] Participants were compensated with a $10 Amazon gift card for participation and entered a raffle for the chance to win a $250 Amazon voucher. Data from this sample has been used elsewhere to present the psychometric properties of the bodily threat monitoring scale (BTMS; Heathcote et al., 2023); data on body mindsets and pain are newly reported here.

Measures

Demographic and Medical Factors

Participants self-reported demographic information including sex, gender, age, race, ethnicity, whether they are still in school, highest degree of education, and employment status. Medical history (age at diagnosis, time off treatment, diagnosis, treatment history) was also self-reported and confirmed by the research team through medical record review. The intensity of treatment rating scale 3.0[23] categorised survivor's treatment intensity based on previous diagnosis, stage or risk level of disease, and treatment modality (level 1 = minimally intensive, level 4 = most intensive). The scale also considers relapse in terms of disease type and frequency. Level 4 was the most intensive and included treatments such as haematopoietic stem cell transplantation for all diseases or chemotherapy for acute myeloid leukaemia. To demonstrate how the scale considers the criteria, survivors of brain tumour are automatically classified at level 2 if one treatment modality has been received, not including a biopsy. If 2 or more treatment modalities have been received, survivors of brain tumour are classified at level 3 and if a haematopoietic stem cell transplantation has been received or if a relapse has occurred, these survivors are classified at level 4. Survivors of osteosarcoma and Ewing's sarcoma are automatically classified at level 3 and can be classified as level 4 depending on recurrence and treatment modality.

Pain

The brief pain inventory (BPI) assessed multidimensional qualities of pain; the BPI has been previously used in paediatric cohorts.[24,25] Three items adapted from the BPI were used to capture pain frequency, average pain intensity, and pain interference over the past 3 months as opposed to a 24-hour period. Pain frequency was assessed by asking survivors how often they felt aches or pains in the last three months on a 6-point Likert scale (1 = less than one day each month, 6 = every day), with scores ranging from 1 to 6 and lower scores representing less frequent pain. Average pain intensity was assessed by asking survivors how much pain they have usually had in the last 3 months on a numeric rating scale from 0 (no pain) to 10 (worst pain possible). Pain interference was assessed by asking how much pain interfered with doing activities that other people their age do in the last 3 months on a numeric rating scale from 0 (I don't miss out) to 10 (I miss out on all activities). We additionally measured the presence of chronic pain by enquiring whether survivors had been experiencing pain either all the time or sometimes for longer than 3 months (no/yes). Of note, survivors were asked to report their pain in general but were not asked if they believed that this pain was related to their previous cancer experience.

Body Mindsets

The body mindset inventory-child version (BMI-C) comprises 8-items that assess three mindsets: the body is capable (2 items; $\alpha = .78$), the body is responsive (2 items; $\alpha = .92$), and the body is an adversary (4 items; $\alpha = .87$). Items are oriented around mindsets about the body in the context of cancer (see Table 1). For all items, individuals respond on a 6-point Likert scale (6 = strongly agree, 1 = strongly disagree) and a mean score is created for each subscale separately. Higher mean scores on each subscale indicate greater endorsement of that mindset. The body mindset inventory (BMI) was initially developed for use in adults.[26] The BMI-C is similar to the adult version but with the language simplified to make the scale appropriate for children as young as 10 years old. Given its novel use in this population, we examined the factor structure of the BMI-C in the current sample of survivors of childhood cancer (n = 102). Bartlett's test of Sphericity suggested that the data were suitable for factor analysis (χ^2 [28]= 380.17, $P < .001$). Exploratory maximum likelihood factor analysis with oblique rotation and with the criterion of eigenvalues >1 yielded a three-factor structure that matched the theoretically derived subscale structure of the BMI. These factors explained 70.12% of the variance with all factor loadings exceeding .5 (Table 1).

Bodily Threat Monitoring

The BTMS captures tendencies to monitor and appraise bodily sensations as symptomatic of something being

Table 1. Exploratory Factor Analysis of the Body Mindset Inventory-Child Version[a]

Body mindset inventory-child version items	Factor loading		
	Factor 1	Factor 2	Factor 3
Body is capable			
Your body can help you deal with cancer	.018	-.032	**.942**
Your body can handle cancer	-.063	.069	**.659**
Body is responsive			
Most of the time, your body can get better on its own	-.006	**1.007**	-.045
Your body can heal on its own	.024	**.833**	.076
Body is an adversary			
Your body is to blame if you have cancer	**.670**	.022	-.124
Having cancer means that your body isn't doing its job	**.876**	-.039	.037
If you have cancer, it means your body has done something wrong	**.905**	-.006	.080
Having cancer means that your body is broken	**.696**	.046	-.050

[a]Factor loadings greater than .30 are bolded

wrong with one's body, with 2 subscales that capture bodily monitoring (α = .92) and bodily threat appraisals (α = .94).[27] The BTMS comprises 19 items and each item is rated on a 5-point Likert scale (0 = not at all like me, 4 = entirely like me). Scores from items are summed, creating a total score ranging from 0 to 76; higher scores represent greater bodily threat monitoring. Cronbach's alpha in this study was .92 for the total score.

Fear of Cancer Recurrence

The fear of Cancer recurrence inventory-child version contains 9 items assessing the presence, frequency, intensity, and duration of fear of cancer recurrence.[28] Items are rated on a 5-point Likert scale (0 = not at all, 4 = a great deal). Item 5 is reverse scored and total scores range from 0 to 36; higher scores reflect greater fear of cancer recurrence. Cronbach's alpha in this study was .89 for the total score.

Help-Seeking Behaviours

The Help Seeking subscale from the Childhood Illness Attitudes Scale measured help-seeking behaviours motivated by illness concerns.[29] Nine items assessed behaviours such as asking to go to the doctor or telling a parent if the pain lasts a week or more. Items are rated on a 3-point Likert scale (1 = none of the time, 2 = sometimes, 3 = a lot of the time). Scores range from 9 to 27; higher scores reflect more help-seeking behaviours motivated by illness concerns. Cronbach's alpha in this study was .83 for the total score.

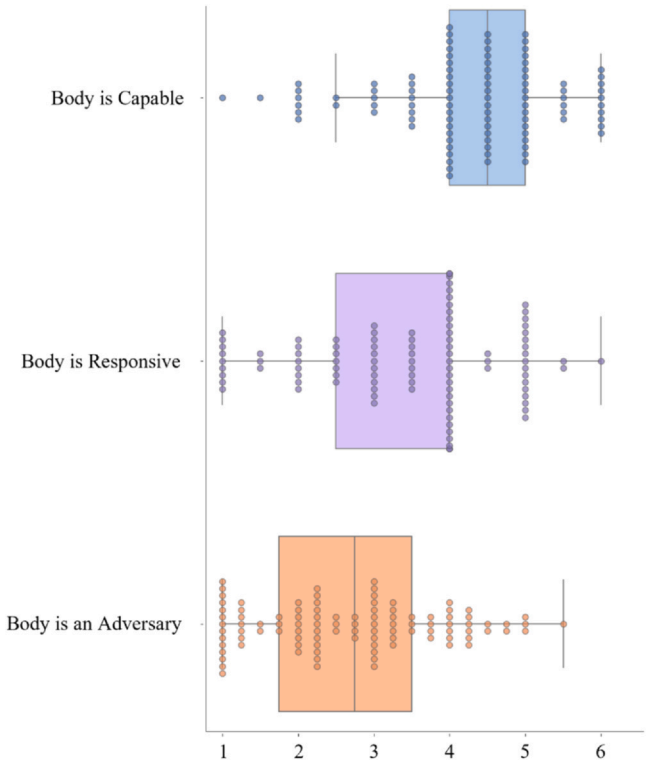

Figure 2. Boxplots Presenting the Distribution and Central Tendencies of body mindset subscale scores in survivors of childhood cancer. The lines at either end of the boxplots represent the minimum and maximum values. on each subscale within the sample, the lines within the box represent the lower quartile, the median, and the upper quartile values for each subscale respectively.

Statistical Analysis

Data were analysed using SPSS version 28,[30] significance levels were set at $P < .05$ two-tailed. Data were assessed for normality then descriptive statistics were used to summarise medical and demographic variables in the sample. The distribution of the body mindset subscales was presented using boxplots created in R version 4.1.3[31] (Fig 2). Pearson correlations and independent sample t-tests examined the univariate relationships between medical and demographic factors, pain characteristics, body mindsets, and threat-related risk factors from the CTI model (bodily threat monitoring, fear of cancer recurrence, help-seeking). A post-hoc power calculation was performed using G*Power version 3.1.[32] Significant correlations among study variables ranged from r = .20 at the lower bound and $r = .40$ at the upper bound (see Results). With 102 participants and a significance level of $P < .05$ (two-sided), we were well-powered to detect correlations over .3 (87% power) and .40 (99%) and underpowered to detect correlations of .20 (53%).

Path Analysis was performed using MPlus version 8.8,[33] using Robust Maximum Likelihood estimation. Conventional χ^2 criterion and standard model fit indices were evaluated to determine the adequacy of the model fit. The comparative fit index,[34] and Tucker-Lewis Index[35] were used, with values exceeding .90 indicating good fit, although ≥.95 is preferred. In addition, the root mean square error of approximation was evaluated with a value of < .08 considered to demonstrate approximate fit.[34,36] A latent variable measurement model for pain was included as the outcome in the path model, comprising pain interference, average pain intensity, and pain frequency. Factors associated with pain from univariate analyses were used in the model. The latent variable of pain was regressed on fear of cancer recurrence, bodily threat monitoring, and the mindset that the 'body is an adversary' (see Results for the rationale for focusing on this mindset), adjusted for sex and age. Fear of cancer recurrence and bodily threat monitoring were regressed on the mindset that the 'body is an adversary', also adjusted for sex and age, with indirect effects from pain to the mindset that the 'body is an adversary' estimated. The proportion of the total effect accounted for by the indirect effect was calculated. Standardised estimates are presented in the results.

Results

Sample Characteristics

One hundred and 2 participants with a mean age of 18.3 years were recruited of whom 43 (42.2%) were still in school; see Table 2 for demographic and clinical data. Survivors had varied cancer diagnoses, the most common being acute lymphoblastic leukaemia (35.6%). The mean age at diagnosis was 11.3 years (SD = 5.8) and the mean time of treatment was 6.0 years (SD = 4.5). Most survivors had received moderately intensive treatment (48%) which corresponds to level 2 on the intensity of treatment rating scale 3.0. Missing data across all items was .69%, all available data were analysed without imputation. Table 3 presents univariate associations of study variables with clinical and demographic factors.

Pain Characteristics in Survivors of Childhood Cancer

Twenty-two survivors (21.8%; 95% Confidence Interval: 14.0–30.8%) reported experiencing chronic pain. In terms of pain frequency in the previous 3 months, 38.8% reported experiencing some aches or pains less than 1 day each month, 5.1% about 1 day each month, 25.5% about 2 or 3 days each month, 14.3% about 1 day a week, 14.3% most days, and 2% every day. The mean average level of pain intensity was 2.52 (SD = 2.13, range = 0–9) and the mean pain interference score was 2.39 (SD = 2.59, range = 0–10). As shown in Table 3, there were no significant associations of pain dimensions with time off treatment, treatment intensity, age at diagnosis, and age. Females reported experiencing significantly more frequent, intense, and interfering pain than males.

Body Mindset Characteristics in Survivors of Childhood Cancer

The median endorsement for each mindset fell in the "somewhat agree" to "agree" range for the 'body is capable' mindset (Mdn = 4.50, SD = 2.10) and the 'body is responsive' mindset (Mdn = 4.00, SD = 1.26), and the "somewhat disagree" to "disagree" range for the 'body is an adversary' mindset (Mdn = 2.75, SD = 1.19). As shown in Fig 2, the scores were widely distributed indicating substantial individual differences in the mindsets that childhood cancer survivors hold about their bodies. The 'body is capable' and 'body is responsive' mindsets were positively, weakly associated (r = .199, P = .049) while the 'body is an adversary' mindset was not significantly associated with the 'body is capable' (r = –.160, P = .111) or 'body is responsive' mindsets (r = –.063, P = .534). Body mindsets were not significantly associated with any medical or demographic factors (Table 3).

Univariate Associations of Pain, Body Mindsets, and Threat-Related Risk Factors

Associations of Pain with Threat-Related Risk Factors

As seen in Table 4, survivors who engage in more bodily threat monitoring reported significantly more frequent, intense, and interfering pain. Pain modelled as a latent variable was also significantly associated with bodily threat monitoring. Survivors who have more fear of cancer recurrence also reported more intense, frequent, and interfering pain. Additionally, pain modelled as a latent variable was significantly associated with fear of cancer recurrence. Lastly, survivors who engage in more help-seeking behaviours reported more frequent but not intense or interfering pain. The latent variable of pain was not significantly associated with help-seeking behaviours.

Associations of Body Mindsets with Pain

As seen in Table 4, survivors who more strongly endorsed the mindset that the 'body is an adversary' reported more intense, frequent, and interfering pain. The latent variable of pain was significantly associated with the mindset that the 'body is an adversary'. There were no significant relationships between pain characteristics or the latent variable of pain with the mindsets that the 'body is capable' and the 'body is responsive'.

Associations of Body Mindsets with Threat-Related Risk Factors

As seen in Table 4, survivors more strongly endorsing the mindset that the 'body is an adversary' reported significantly more bodily threat monitoring, while

survivors endorsing the mindset that the 'body is responsive' reported significantly less bodily threat monitoring. The 'body is capable' mindset was not significantly associated with bodily threat monitoring. Survivors holding the mindset that the 'body is an adversary' reported greater fear of cancer recurrence. There were no significant relationships between the mindsets that the 'body is capable' and the 'body is responsive' with fear of cancer recurrence. Finally, survivors holding the mindset that the 'body is capable' reported engaging in more help-seeking behaviours; the 'body is an adversary' and the 'body is responsive' mindsets were not associated with help-seeking behaviours.

Path Analysis Informed by the Cancer Threat Interpretation Model

A structural path model informed by the CTI model (see Supplemental Files) with pain modelled as a latent

Table 2. Demographic and Clinical Characteristics of the Sample

Variable	*Category*	*n*	*%*	*M (SD)*	*Range*
Sex	Male	47	46.1	–	–
	Female	55	53.9		
Gender	Boy/ Man	48	47.1	–	–
	Girl/Woman	52	51		
	Genderfluid/ Genderqueer	1	1		
	Transman	0	0		
	Transwoman	0	0		
	Other	1	1		
Age	–	–	–	18.3 (3.7)	11–25
Race	White	42	42	–	–
	Asian American	30	30		
	Mixed Race	11	11		
	Hawaiian Native or Pacific Islander	1	1		
	Other	16	16		
Ethnicity	Hispanic or Latino	69	68.3		
	Not Hispanic or Not Latino	32	31.7		
Highest level of education	Did not Complete High School	1	1.7		
	Completed High School	14	24.1		
	Completing or Completed an Associate's Degree	4	6.9		
	Completing or Completed an Bachelor's Degree	35	60.3		
	Completing or Completed an Master's Degree	1	1.7		
	Completing or Completed Education Beyond a Master's Degree	1	1.7		
	Other	2	3.4		
Employment status	Student	32	55.2		
	Unemployed	6	10.3		
	Part-Time Employed	9	15.5		
	Full-Time Employed	11	19.0		
Treatment intensity	Minimally Intensive	6	5.9	2.6 (.8)	1–4
	Moderately Intensive	49	48		
	Very Intensive	30	29.4		
	Most Intensive	17	16.7		
Diagnosis	Acute Lymphoblastic Leukaemia	36	35.6		
	Acute Myeloid Leukaemia	8	7.9		
	Hodgkin's Lymphoma	17	16.8		
	Non-Hodgkin's Lymphoma	14	13.9		
	Ewing Sarcoma	4	4		
	Osteosarcoma	4	4		
	Soft Tissue and Other Sarcoma	3	3		
	Germ Cell Tumour	3	3		
	Neuroblastoma	2	2		
	Wilm's Tumour	1	1		
	Brain/CNS	1	1		
	Carcinoma	2	2		
	Ovarian Cancer	4	4		
	Multiple Cancer	2	2	–	–
Age at diagnosis	-			11.3 (5.8)	1–23
Time off treatment	-			6.0 (4.5)	.8–19

NOTE. *Age, Age and Diagnosis, and Time off Treatment reported in years. The highest level of education and employment status reported for those who were not at school during the time of the study n = 58.

Table 3. Pearson Correlations for Medical and Demographic Factors with Body Mindsets, Pain, and Threat-Related Risk Factors

		Sex (t)	Age (r)	Age at diagnosis (r)	Time off treatment (r)	Treatment intensity (r)
Pain characteristics	Pain frequency	-2.782**	.032	.045	-.017	-.123
		.007	.752	.662	.872	.229
	Pain interference	-2.403*	.051	-.078	.125	.039
		.018	.611	.438	.212	.696
	Average pain intensity	-2.727**	.163	-.012	.138	.044
		.008	.103	.905	.172	.665
Body mindsets	Body is capable	.928	-.013	-.045	.063	.092
		.356	.897	.656	.536	.365
	Body is responsive	1.572	-.025	-.126	.067	.168
		.119	.803	.209	.508	.093
	Body is an adversary	-.228	.034	.060	-.002	-.084
		.820	.735	.548	.981	.401
Threat-related risk factors	Bodily threat monitoring	-2.045*	.345***	.186	.096	.001
		.040	< .001	.067	.350	.988
	Fear of cancer recurrence	-2.161*	.252*	.210*	-.052	.084
		.033	.012	.037	.609	.409
	Help-seeking	.632	-.150	- .147	.146	-.064
		.529	.136	.146	.149	.525

NOTE. Top line for each variable represents the t or r value, the second line represents the *P* value; *$P < .05$, **$P < .01$, ***$P < .001$. For Sex effects, negative *t* values represent females > males.

variable was tested (see Fig 3). The model had a good fit as determined by a non-significant chi-square ($\chi^2 = 11.0$, df = 10, $P = .354$) and the fit indices (comparative fit index = .99, Tucker-Lewis Index = .99, root mean square error of approximation = .032). The 'body is an adversary' mindset, bodily threat monitoring, and participant sex was significantly associated with pain. Both bodily threat monitoring and fear of cancer recurrence were associated with the mindset that the 'body is an adversary' and age. There was a significant total indirect effect of the mindset that the 'body is an adversary' to pain, via bodily threat monitoring and fear of cancer recurrence (total indirect effect = .100, $P = .02$; total effect = .314, $P < .01$), which accounted for 31.8% of the total explained variance in pain. There were no significant specific indirect effects.

Discussion

In this study, we empirically tested the CTI model in a sample of survivors of childhood cancer (aged 11–25). Our findings largely aligned with the CTI model, demonstrating that greater fear of cancer recurrence, bodily threat monitoring, and help-seeking behaviours were associated with worse pain in survivors of childhood cancer. We also offered a novel extension to the CTI model, showing that pain and its threat-related correlates are associated with certain mindsets about the body.

In the current sample, 21.8% of the survivors reported chronic pain, which is comparable to extant research.[2] Moreover, 14.3% reported experiencing pain most days, also aligning with previous studies.[4] Overall, 17.9% reported experiencing pain that is moderate to highly intense (≥5 out of 10 average pain intensity). Additionally, 23.5% of the participants reported experiencing moderate to severe pain (≥5 out of 10 average pain interference). Taken together, our findings mirror those of existing research indicating that while many childhood cancer survivors report little or non-interfering pain, a subset experience persistent, frequent, intense, and interfering pain.[2,4] These young people have a greater clinical need for comprehensive pain management as part of their survivorship care.

Childhood cancer survivors who engaged in more bodily threat monitoring reported more frequent, intense, and interfering pain. These results corroborate findings from a study by Pradhan and colleagues[37] which found that, in women with a history of breast cancer, the tendency to interpret ambiguous health-related information as threatening was associated with worse pain, and this interpretational style moderated the association between pain and fear of cancer recurrence. Findings also align with qualitative[38,39] and quantitative[40] data showing that cancer survivors are vigilant for ambiguous somatic symptoms and interpret pain as a sign of possible cancer recurrence.[3,11,39,41] We found that survivors who experience greater fear of cancer recurrence report more frequent, intense, and interfering pain. Our findings can also be considered within broader frameworks including the self-regulatory executive function model[42] which has been applied within the context of somatic distress. The self-regulatory executive function model describes cognitive attentional syndrome (CAS), a thinking style encompassing repetitive worry, maladaptive coping strategies, and attentional biases towards threat-related information.[43] Although bodily threat monitoring is body-specific, the construct overlaps with CAS. Studies reveal that adult survivors who have more negative metacognitive beliefs, indicative of information processing styles in CAS, report a greater fear of cancer recurrence.[44,45] In both clinical and non-clinical adult populations who experience concern

Table 4. Pearson Correlations for Associations of Pain, Body Mindsets, and Threat-Related Risk Factors

Variable	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*
1. Body is capable	1									
2. Body is responsive	.199*	1								
	.49									
3. Body is an adversary	-.160	-.063	1							
	.111	.534								
4. Pain frequency	-.011	-.095	.249*	1						
	.917	.353	.013							
5. Average pain intensity	-.120	-.029	.225*	.643***	1					
	.235	.777	.024	< .001						
6. Pain interference	-.189	.142	.292**	.537***	.632***	1				
	.059	.155	.003	< .001	< .001					
7. Latent variable of pain*	-.014	-.010	.320**	.767***	.809***	.736***	1			
	.252	.447	.002	< .001	< .001	< .001				
8. Bodily threat monitoring	.155	-.233*	.224*	.383**	.323***	316***	.430**	1		
	.132	.028	.027	< .001	< .001	< .001	.001			
9. Fear of cancer recurrence	-.043	-.172	.273**	.380**	.296**	.388***	.430**	.661**	1	
	.675	.086	.006	< .001	.003	< .001	.001	< .001		
10. Help-seeking	.250*	-.061	.040	.211*	.110	.154	.180	.293**	.003	1
	.013	.552	.691	.039	.278	.127	.134	.004	.978	

NOTE. Top line for each variable represents *r* value, second line represents *P* value.
*$P < .05$.
**$P < .01$.
***$P < .001$.
*Latent variable of pain comprises scores of pain frequency, average pain intensity, and pain interference.

about symptoms, positive relationships between dysfunctional metacognitive beliefs with somatic distress and pain have been identified.[46] Overall, our results support the wider literature indicating that cognitive styles comprising negative thinking and threat monitoring exacerbate distress and symptoms in the context of pain.

Pain is a source and trigger of uncertainty in survivorship. We provide novel evidence that there are individual differences in the mindsets that young survivors hold about their bodies within the uncertain context of cancer survival. In the current sample, body mindsets were not merely a reflection of demographic or medical status—we observed no significant associations between mindsets and medical or demographic characteristics, aligning with previous research in adults.[26] This suggests that individuals with the same cancer diagnosis or treatment history may hold different body mindsets. Survivors who endorsed the mindset that the 'body is an adversary' reported more frequent, intense, and interfering pain, greater bodily threat monitoring, and greater fear of cancer recurrence. These findings indicate that viewing one's body as an untrustworthy adversary is associated broadly with worse pain-related health outcomes in childhood cancer survivors. Conversely, survivors who endorsed the mindset that the 'body is responsive' reported less bodily threat monitoring, suggesting that viewing one's body as able to respond and heal after cancer may evoke less vigilance for and concern about somatic symptoms. Intriguingly, survivors who endorsed the 'body is capable' mindset reported greater help-seeking. A moderate degree of help-seeking likely reflects an adaptive approach to health management in cancer survivorship and believing that one's health has the capacity to improve after intensive cancer treatment may promote this. The degree to which different body mindsets may evoke excessive healthcare use or avoidance remains unexplored.

In a path model, there was a significant direct effect of the 'body is an adversary' mindset on pain, as well as a combined indirect effect via bodily threat monitoring and fear of cancer recurrence. This provides preliminary support that holding the mindset that the 'body is an adversary' may shape pain experiences through bodily threat monitoring and fear of disease recurrence. As this study is cross-sectional, we cannot draw conclusions about the direction of these effects; experiencing more pain may reinforce the mindset that the 'body is an adversary' as well as drive more fear and monitoring. Likewise, holding the mindset that the 'body is an adversary' may exacerbate or maintain pain and its impact. It is unlikely that body mindsets cause pain, but instead, they may act as maintaining factors, with reinforcing effects over time. Longitudinal research following individuals as they finish cancer treatment, and interventions targeting mindsets, could also determine their causal influence. Studies demonstrate that mindsets across broad domains, including mindsets about intelligence, stress, and illness, are malleable and can have downstream effects on behaviour, well-being, and physiology.[18] For example, employees who viewed videos that aimed to instil the mindset that 'stress is enhancing', as opposed to debilitating, reported improvements in work performance and general health.[16] Additionally, a randomised controlled trial in adults receiving cancer treatment demonstrated that brief videos could instil the mindsets that cancer is manageable and that the body is capable of handling cancer treatment, which significantly improved health-related quality of life and symptom distress.[26] Changes in these mindsets were demonstrated to mediate the intervention effect, providing evidence that body

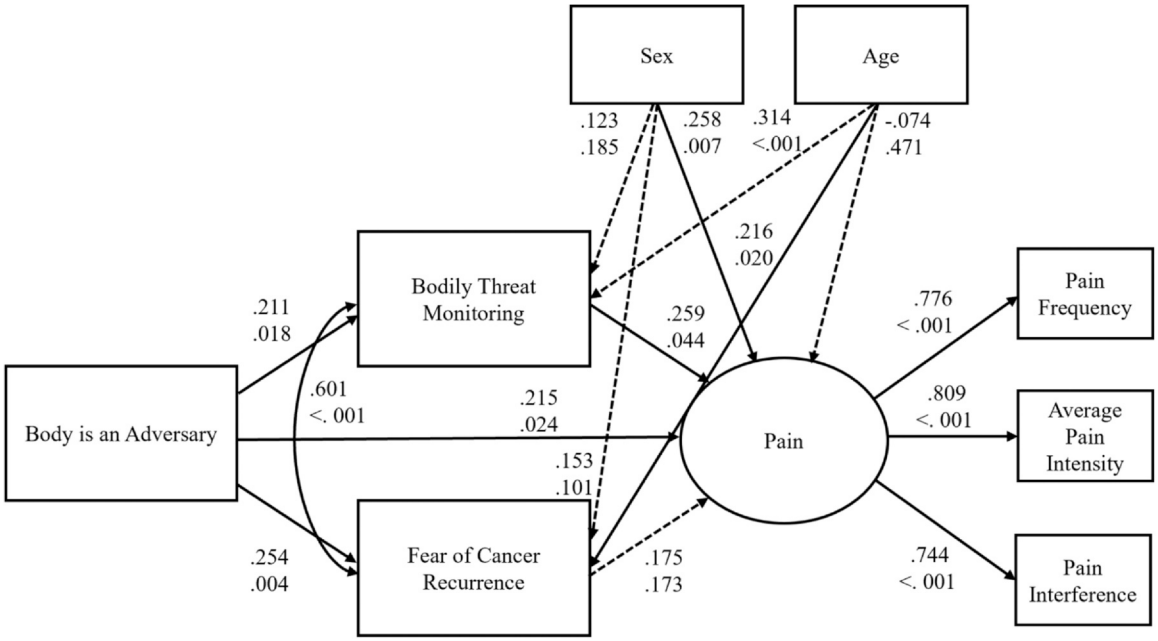

Figure 3. Path analysis informed by the cancer threat interpretation model. Latent variable of pain comprises scores of pain frequency, average pain intensity, and pain interference. Top value for each path represents the standardised estimate, bottom value for each path represents *P* value. Solid lines indicate significant paths.

mindsets are modifiable and are mechanisms of change in therapeutic interventions. A similar intervention approach could support young survivors to recognise the mindsets that they hold about their bodies, to notice the effects of these mindsets on their cognitive and emotional responses to pain, and equip them with skills to adopt more helpful mindsets. This could reduce pain-related distress and interference, improving quality of life.

This study has limitations, pointing toward future research. Firstly, and as discussed above, the data are cross-sectional, and observed indirect effects of mindsets through bodily threat monitoring and fear of cancer recurrence in path analyses require additional investigation with longitudinal or interventional designs. Secondly, the research was underpowered to detect correlations of small effect sizes. Thirdly, items measuring the 'body is capable' mindset were orientated around the body handling cancer, which may be less relevant in survivorship. The mindset that the body can recover from treatment, rebuild strength and fitness, and support the young person in achieving their life goals is likely more applicable in the survivorship context and warrants investigation. Fourthly, the body mindset measure captured three pre-defined mindsets that are proposed to be relevant in the context of health and illness. Yet, there may be other mindsets about the body that are relevant for understanding how individuals navigate complex health challenges more broadly as well as cancer survivorship specifically; qualitative work could identify other relevant mindsets which could be integrated into future versions of the body mindset inventory. Fifthly, we consider limitations regarding medical, demographic, and socio-cultural factors. Survivors of bone cancer and CNS tumours were underrepresented in the sample. As these survivors have been shown to report greater pain,[11] future research should consider body mindsets and their relationship with pain experiences specifically in these diagnostic groups. Black and Hispanic survivors were also underrepresented in the sample. Exploring body mindsets in racially and ethnically diverse samples will be important. Social and environmental factors shape mindsets within cultural frameworks,[47] and future research should investigate how body mindsets and their effects are shaped by families and peers, socioeconomic status including access to medical care, and broader sociocultural contexts that shape how one responds to medical illness.

Conclusions

In conclusion, our findings indicate that a sub-group of childhood cancer survivors experience persistent, frequent, and interfering pain. The findings also provide empirical support for the CTI model in that proposed threat-related risk factors, specifically more bodily threat monitoring, fear of cancer recurrence, and help-seeking behaviours, were associated with more pain and pain interference. We provide novel evidence that young survivors hold diverse mindsets about their bodies and that certain body mindsets are associated with greater pain and threat-related risk factors. Body mindsets may be a novel target to embed in comprehensive post-cancer pain management approaches.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jpain.2023.07.030.

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