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Article type : Research Report

Editor : Suellen Walker

The Relationship between Parental Factors, Child Symptom Profile and Persistent  
Postoperative Pain Interference and Analgesic Use in Children

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/PAN.14031](https://doi.org/10.1111/PAN.14031)

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Sources of Support: This project was conducted without external support or funding.

**Running Title:** Parent, Child & Persistent Postoperative Pain

### **Clinical Implications**

**What is already known about this topic?** Parent catastrophizing and protectiveness about their children's pain has been associated with worse postoperative pain outcomes – including pain persistency and pain-related dysfunction.

**What new information this paper adds:** Findings reveal that the association between parental factors and persistent postoperative pain was attenuated by the child's psychologic and somatic symptom profile. Addressing children's complex symptom presentation prior to surgery may promote improved pain outcomes.

### **Abstract**

**Objectives:** Both parental and child factors have been previously associated with persistent or recurrent postoperative pain in children. Yet, little is known about the relative contribution of parent factors or whether child symptom factors might impact the association between parent factors and long-term pain. The aim of this study was to explore the associations between parent factors, child symptomology and the child's long-term pain outcomes after surgery.

**Methods:** This prospective, longitudinal study included parents and their children who were scheduled to undergo spinal fusion for underlying scoliosis. Parents completed baseline surveys about their pain history, pain relief preferences (i.e., preference to relieve their child's pain vs. avoid analgesic risks) and pain catastrophizing (i.e., beliefs about their child's pain). Children were classified previously into high vs. low symptom profiles at baseline based on their self-

reported pain, catastrophizing, fatigue, depression, anxiety. Children were assessed one year after surgery for their long-term pain interference scores and analgesic use. Serial regression modeling was used to explore whether associations between parent factors and the outcomes were changed when accounting for child factors.

Results: 76 parent/child dyads completed all surveys. Parental preferences and catastrophizing were atemporally associated with the child's baseline psychological-somatic symptom profile. Though parent and child factors were both associated with the long-term pain outcomes, when all three factors were accounted for, the associations between parent factors and long-term pain was fully attenuated the child's profile.

Discussion: These findings suggest that the relationship between parent factors and long-term postoperative pain outcomes may be dependent on the child's symptom profile at baseline. Since there may be bidirectional relationships between parent and child factors, interventions to mitigate long-term pain should address child symptoms as well as parental factors.

**Key Words:** Persistent postoperative pain, symptomology, parental pain catastrophizing, children, adolescents

## INTRODUCTION

A high prevalence of persistent post-operative pain has been reported in children, with overall rates up to 22%<sup>1</sup> and highest rates (up to 65%) among those undergoing major surgeries such as posterior spine fusion (PSF).<sup>2</sup> Persistent pain not only affects physical and social functioning and the child's overall quality of life, but may lead to long-term opioid or analgesic use for a significant number of children.<sup>3,4</sup> Furthermore, pain can persist into adulthood for up to two thirds of those with chronic or recurrent childhood pain.<sup>5</sup> A better understanding of persistent pain and associated risk factors is, therefore, critical to identify the most important mitigation targets.

The risk factors for persistent postoperative pain in children and adolescents are complex in nature with data, to date, suggesting a variety of underlying psychological and somatic pathways including anxiety, depression, and sleep dysfunction.<sup>6,7</sup> We recently reported that both early postoperative pain and a persistent pain trajectory after PSF were predicted by the child's psychologic/somatic pain and symptom profile prior to surgery.<sup>4,8</sup> Specifically, 30% of children who were differentiated prior to surgery as having co-occurring high symptomology by their self-reported scores for depression, fatigue, pain interference, catastrophizing, and

neuropathic pain had higher pain intensity, pain-related interference and analgesic use one year post-operatively. These data suggested that a significant number of children with scoliosis exhibit high co-occurring symptomology that increases their vulnerability to persistent pain.

However, in addition to child factors, parent factors such as catastrophizing (i.e., the degree to which they fear or magnify their child's pain) and protective behaviors have been associated with persistent postoperative and other types of chronic childhood pain and pain-related dysfunction.<sup>9-11</sup> Previous investigators have postulated a feedback cycle where a child's pain perceptions and experiences are influenced by their parents' perceptions and protective behavioral responses,<sup>12</sup> perhaps through social learning.<sup>13</sup> Indeed, some data suggest shared pain beliefs between parents and their adolescents based on concordance in their catastrophizing scores.<sup>9</sup> Others have found a lack of concordance between parent and child catastrophizing, their memories about immediate postoperative pain, and found no associations between parent factors and postoperative or chronic pain outcomes when child factors were accounted for.<sup>12,14</sup> Such conflicting findings suggest the possibility of indirect relationships between parent, child and persistent pain. Most pain researchers and clinicians agree that a developmentally sensitive approach to pediatric pain considers the role of parents in the development or maintenance of their children's pain.<sup>11</sup> To guide appropriate interventions, it is, therefore important to understand the degree to which parental beliefs or behaviors and the child's psychologic or symptom presentation influence and, perhaps, how these factors work together toward longer-term pain outcomes.

This study represents the third aim of our earlier work and was designed to explore the contribution of parent factors toward the child's development of persistent postoperative pain. Specifically, we aimed to explore whether the purported association between parent factors and pain might be indirectly or partially explained by the child's symptom profile. Specifically, we tested the hypotheses that a) parental factors would be associated with the child's baseline symptom profile and their long-term pain outcomes, and that b) the association between parental factors and the child's pain outcomes is influenced by the child's psychosomatic symptom profile.

## **MATERIALS AND METHODS**

This study included parents and their children (aged 10-17 years) with scoliosis who took part in the longitudinal portion of a large, prospective observational study (July 2014 through December 2017). We previously reported child characteristics associated with long-term, postoperative outcomes.<sup>4,8</sup> This study, in contrast focuses on our third aim that focused on parent/child dyads who completed all baseline and follow-up surveys. We included those who

were English-speaking and excluded parents whose children could not independently self-report pain or were undergoing a secondary major orthopedic procedure (e.g., repeat spine fusion). Approval from the University of Michigan institutional review board (IRBMED HUM#86972) and written parental consent/child assent was obtained prior to participation.

## Measures

The following baseline measures were used in this study:

**Parent Pain Catastrophizing:** Parents completed this survey which measures their thoughts such as fear/worry about their child's pain. This scale has excellent internal consistency (Cronbach's  $\alpha=0.88$ ) and scores have been associated with children's pain outcomes in a number of parents whose older children and teens had chronic or postoperative pain.<sup>15</sup>

**Parent self-reported pain history:** Parents recorded whether they had experienced any recent pain condition using a binary (yes/no past pain) response option to the question, "*Have you experienced any painful condition in the past six months?*".

**Parent Pain Relief Preference:** The PR Pref scale<sup>16</sup> contains six analgesic-related risk-benefit items to assess the degree to which parents prefer to relieve their child's pain or, conversely, to avoid analgesic-related adverse effects. The instrument is based on similar scales which have been found to predict medication adherence (i.e., stronger benefit preferences are associated with greater medication use). We have previously demonstrated that parents' pain relief preferences strongly predict their analgesic administration decisions (both hypothetically and after surgery).<sup>16,17</sup> As such, we incorporated this measure as a proxy for protective preferences. Items reflect the degree to which parents agree with statements such as, "*Reducing side effects is more important than getting rid of my child's pain; Avoiding nausea and vomiting is more important to me than my child's complete pain relief; Pain relief is more important than the side effects of prescription pain drugs.*" Each is scored from -2 (strongly disagree) to +2 (strongly agree), yielding overall scores ranging from -12 (strong preference to avoid risk) to +12 (strong preference to relieve pain). Scores of "0" reflect parents' relative ambivalence regarding the importance they place on relieving their child's pain versus avoiding the potential risks of potent analgesics. This instrument was previously shown to have sufficient internal consistency (Cronbach's alpha 0.763 [95% CI 0.73, 0.80] and predictive validity for analgesic treatment decisions among parents of children and teens undergoing surgery.<sup>16,17</sup>

**Child Psychologic and Somatic Symptom Profile:** This variable was previously derived from a two-step cluster analyses that differentiated children based on their self-reported baseline symptomology as measured by the instruments described below. We used the log-likelihood

distance to differentiate children based on the ideal number of homogeneous structures suggested by the data. These analyses yielded a two-cluster solution that classified children into high symptom and low symptom clusters. Children in the high symptom cluster had higher scores on the following psychological and symptom assessments as previously reported.<sup>4,8</sup>

**Pediatric Patient-Reported Outcome Measurement System (PROMIS) Short Forms (Pain Interference, Fatigue, Depression, Anxiety):** These tools were developed by the National Institutes of Health to measure various health domains or symptoms common across chronic disorders in children. We used the short forms (SF v 2.0) that contained 8 items scored using a 5-point response (never, almost never, sometimes, often, almost always).<sup>18</sup> Thus, scores range from 0-40 for each measure. They have been tested using item bank development and classification and the short forms are considered to efficiently and accurately capture the most informative items for each set of symptoms.<sup>18</sup> Data supports both the internal consistency of these scales (coefficients ranging from 0.86 for depression to 0.88 for pain interference) as well as their test-retest reliability in children as young as 8 years through adolescence (0.62 for pain interference to 0.76 for fatigue and depression).<sup>19</sup>

**PainDETECT:** This 9-item survey includes multiple qualitative descriptors to differentiate neuropathic-type pain symptoms (e.g., *burning, tingling, sudden pain, numbness, pain spread*) from nociceptive pain. Although the instrument has been used to diagnose neuropathic pain in adults, we used the tool to provide a score of symptoms consistent with neuropathic pain. The measure was previously found to have good internal consistency (Cronbach  $\alpha = 0.757$ ) and reliability in children aged 10-17 (ICC = 0.654).<sup>8</sup>

**Child Pain Catastrophizing:** This 13-item instrument (score range 0 to 52) reliably measures thoughts about anticipated pain (e.g., negative affect, fear or concern) in children ages 9-15 years ( $\alpha=0.87$  to 0.92).<sup>20</sup> The instrument has excellent predictive validity for chronic pain disability in older children and teens.<sup>21</sup>

#### **Longitudinal Outcomes:**

- Long-term pain-related interference was assessed using the child-reported PROMIS measure.
- Long-term analgesic use was assessed by the child's response to whether or not and how frequently they had taken any analgesic (prescribed or over the counter) within the past week of the one-year clinic visit or survey.

#### **Procedure:**

Parents and children simultaneously and independently completed separate baseline surveys (parents used paper/pencil format while children used a tablet) in the preoperative orthopedic clinic in the presence of a research assistant approximately two weeks before surgery. Children were surveyed in person during their one-year postoperative clinic visit to record the outcomes. Children who cancelled their one-year appointment were surveyed by mail.

### **Statistical Analyses:**

We used SPSS (version 24) to analyze all data. For this study, we focused on parent factors and how they, in conjunction with child factors contributed to the child's 1-year postoperative pain outcomes. First, we first used a two-step regression model to examine the relative contribution of parent factors (sex, past pain, parent catastrophizing and pain relief preferences) and child factors (sex, age, symptom profile) toward the outcome, one-year pain interference. Next, we tested our hypotheses by using sequential regression models followed by the Sobel test for significance of the indirect effect of the parent variables accounting for the child symptom profile.<sup>22</sup> Our first series examined the association between parent catastrophizing and the longitudinal outcome, long-term pain interference. At Step 1, we regressed long-term pain interference onto parent catastrophizing; at Step 2, we regressed child symptom profile onto parent catastrophizing and at Step 3, we regressed the pain outcome onto both parent and child factors. The next series followed the same process but with the independent variable, parent pain relief preference and the long-term outcome, Analgesic Use. We present  $\beta$  coefficients or Adj. $\beta$  with 95% confidence intervals [95% CI], and p values (<.05 accepted as significant).

### **RESULTS**

Seventy-six children/parent dyads completed both baseline and long-term follow-up surveys. As shown in Figure 1, there were no differences between the group lost to follow-up and those who completed their one-year survey in parent or child characteristics. A majority of parent participants were female (79%) as were their children (78%). At baseline, there were 21 children (28%) with a High Symptom Profile and 55 (72%) with Low Symptom Profile. Children's long-term pain interference scores ranged from 0 to 30 with an mean of 5.64 [95% CI 4.1, 7.2]. Forty-five children overall (41%) reported analgesic use at one year; 29% reported use once or twice per month, 29%, once or twice per week, and 2.6% reported daily use. All of these reported use of over-the-counter non-opioids, while only 2 children reported using opioids for pain management.

Our preliminary two-step linear regression model demonstrated that parent factors predicted 20% of the variance in the child's long-term pain interference scores while child factors predicted an additional 22.5% of the variance ( $r^2$  change .225;  $p < 0.001$ ; see Table 1).

Aim 1: The first steps of our sequential regression models supported, in part, our first hypothesis. Specifically, parent catastrophizing predicted the longitudinal outcome, long-term pain interference ( $\beta = 0.184$ ;  $p = 0.011$ ) but not long-term analgesic use ( $\beta = 0.01$ ;  $p = 0.641$ ). Conversely, parents' pain relief preference scores predicted both long-term outcomes (pain interference:  $\beta = 0.64$ ;  $p = 0.009$ ; analgesic use:  $\beta = 0.165$ ;  $p = 0.038$ ). Parent pain history was not associated with long-term outcomes (Adj. OR 2.98 [-0.10, 6.06] .058).

Aim 2: Sequential regression models supported the associations between parent factors, child symptom profile and the outcomes of interest as shown in Figures 2, 3 and 4. Parent catastrophizing was not associated with analgesic use ( $\beta = 0.010$ ;  $p = 0.641$ ), we therefore, did not explore the impact of child symptom profile on this association. As demonstrated at Step 3 of the remaining models, the association between parent factors and the longitudinal outcomes was fully attenuated when parent and child factors were accounted for in Step 3.

## DISCUSSION

Findings from this study demonstrated that parent catastrophizing and pain relief preferences predicted 20% of the variance in their children's long-term postoperative pain interference, while the child's symptom profile contributed another 22.5% of the variance. Both of these parent factors were contemporaneously associated with the child's symptom profile. Additionally, parent catastrophizing was associated with the child's long term pain interference, and their pain relief preferences with both long-term pain interference and analgesic use. Finally, the child's baseline psychosomatic symptom profile fully attenuated the relationship between parent factors and child's long term pain outcomes. This finding suggests that the association between parent factors and long-term postoperative pain may be at least partially dependent on the child's symptom profile.

Across multiple studies, parent catastrophizing has been associated with worse pain outcomes in children. For instance, parent catastrophizing assessed in the acute post-operative period was a primary predictor of persistency and degree of their child's pain one year later.<sup>23</sup> Similarly, parent but not child preoperative catastrophizing predicted a late recovery trajectory and worse pain outcomes one year after surgery.<sup>10</sup> Parent catastrophizing and psychological factors such as their own depression and anxiety have also been associated with children's chronic non-surgical pain and functional outcomes as well as children's general psychological symptoms.<sup>11</sup> Although earlier data suggested that such associations may be mediated by



parents' exaggerated protective responses, these cross-sectional data found that parental responses including protecting and monitoring did not impact the child's pain, while the parental pain and psychological profile (including catastrophizing) did.<sup>11</sup> Our longitudinal findings may add some nuance to this contradiction, revealing that the association between parental factors and child pain may be indirectly influenced by the child's psychosomatic symptom profile. That is, the relationship between parent factors and child pain outcomes may be indirect with the mechanism of this relationship the child's overall symptomology. This suggests that high symptomology that includes depression, pain and fatigue in children may be associated with heightened pain-related fears, worry and protective instincts in parents.

Other evidence highlights the relative impact of child factors on their pain outcomes above and beyond parent factors. For instance, child but not parent catastrophizing was previously associated with both pre-surgical pain and 6-week postsurgical pain outcomes among adolescents undergoing spinal fusion.<sup>14</sup> Lastly, decreases in maladaptive parenting behaviors following cognitive-behavioral interventions did not correspond to decreases in children's pain or functional disability in two longitudinal studies.<sup>24</sup> This latter finding suggests the potential for augmenting risk factors apart from parental behaviors.

These and other recent data suggest a complex relationship between the parent and child that factors into pain-related disability.<sup>9,25</sup> Previous data have shown that children who exhibited greater distress behavior elicited higher parental catastrophizing.<sup>9</sup> These investigators suggested that, in turn, parents who catastrophize may elicit heightened pain behaviors from their children, and higher parental vigilance may reinforce and maintain the pain behaviors. Indeed, nearly three quarters of parent-adolescent dyads in that study exhibited concordant catastrophizing scores, suggesting similar or possibly inter-dependent pain beliefs.<sup>9</sup> These similarities may lead to shared family behaviors that contribute to functional impairment including avoidance of school, activity and increased medication use.

Notably, we also found that parental pain relief preferences (i.e., their relative preference to relieve their child's pain vs. avoid risk) was associated with the child's persistent analgesic use at one year and that this association was fully attenuated by the child's psychosomatic symptom profile. Parents make most pain management decisions for their children, and we have previously demonstrated that their pain relief preferences influence their decisions to administer analgesics to children. The present findings uniquely emphasize the importance and contribution of the child's symptomology toward long-term treatment decisions. Children in the high symptom cluster exhibited higher baseline scores for depression, catastrophizing, fatigue, pain-related interference, and neuropathic-type pain symptoms. Our findings suggest that this

overall symptomology drives long-term postoperative pain outcomes in children. Thus, as previously suggested,<sup>9</sup> the child's degree of symptoms and distress may be most important toward understanding long-term pain disability and treatment choices.

Results from this study highlight the crucial importance of a broader psychological symptom assessment of children who present for major surgery. Persistent or recurrent postoperative pain is all too common in those who present for surgery. One in five children report continued pain one year after major surgery and up to 5% of those who underwent surgery have repeated or persistent opioid use.<sup>3</sup> Given that the child's psychosomatic symptom profile fully attenuated the association between parent factors and pain outcomes, assessment of such is crucial for predicting which children will likely struggle with ongoing pain and functional interference over the long-term. Results support the importance of interdisciplinary treatment targeting children's mood, anxiety, and sleep concerns in order to mitigate risk and improve functional outcomes after surgery. Prioritizing treatment of the child's psychologic and somatic symptoms may, in turn, have a positive impact on parents. In effect, this may redirect the negatively reinforcing bidirectional relationships that promote avoidance, exacerbate pain, and lead to functional impairment.

The longitudinal nature of this data supports the directionality of the predictive effects of parents and child factors on one-year outcomes. However, important limitations remain in the interpretation of these findings. First, this study relied on self-report of symptoms and beliefs by parents and children both at baseline and at one year. There may be a positive or negative bias in self-report of symptoms, and such measures may not detect momentary changes and interactions that could more directly influence day to day pain-related functioning. Secondly, most of the parents in this study were mothers and most of the children, girls. As such, our findings are difficult to generalize to other more heterogeneous populations or those with varying pain conditions. Future studies may include use of ecological momentary assessment of pain and cognitive, emotional, and behavioral responses of children and parents, and may compare patterns of coping styles and pain-related outcomes across mothers, fathers, as well as boys and girls. Finally, parent and child factors were assessed concurrently at baseline, and thus we cannot suggest that the parent factors predict the child's symptoms or that the child symptoms predict the parental responses. Despite this atemporal relationship, we were able to demonstrate complete attenuation of the association between parent factors and long-term outcomes.

In summary, parent factors contributed to 20% of the variance in long-term postoperative pain-related interference, while child factors, primarily their baseline symptomology, contributed

23% to the variance. Complete attenuation of the association between parent factors and long-term pain outcomes suggests that parental contribution is indirect and through the child's symptom profile. These findings may help guide future interventions to focus more directly on the child's presenting psychologic and somatic symptomology prior to surgery as this may better influence parental responses and long term outcomes.

**Table 1.** Contribution of Parent and Child Factors toward the Child's Long-Term Pain Interference Scores (data presented as adj.β [95% confidence interval], p value)

	<b>Step 1;</b> $r^2=.203$ ; F 4.13 (df4); $p=.005$	<b>Step 2;</b> $r^2=.428$ ; F 6.62 (df7) $p<.001$ $r^2$ change = .225; $p<0.001$
Parent Female	-0.52 [-4.31, 3.28]; .786	-0.801 [-4.49, 2.89]; .666
Parent Past Pain	2.98 [-0.10, 6.06], .058	2.45 [-0.25, 5.16], .074
Parent Catastrophizing	0.18 [0.04, 0.32], .014	0.05 [-0.08, 0.19], .449
Parent Pain Relief Preference	0.51 [0.02, 0.99], .040	0.33 [-0.11, 0.76], .135
Child age		0.02 [-0.78, 0.81], .961
Child Female		-0.49 [-4.16, 3.18], .789
Child High Symptom Profile		7.96 [4.72, 11.19], $<.001$

### Legend for figures

**Figure 1.** Diagram of Subject Recruitment and Participation

**Figure 2.** Three-step regression model depicting the associations between Parent Catastrophizing and the Outcome, Long-Term Pain Interference. Child Profile = Psychologic-Somatic Symptom Cluster. Sobel Test Statistic=2.81;  $p=.005$ .

**Figure 3.** Three-step mediation model depicting the associations between Parent Pain Relief Preferences and the outcome, Long-Term Pain Interference. Child Profile = Psychologic-Somatic Symptom Cluster. Sobel Test Statistic = 1.67;  $p=.047$ .

**Figure 4.** Three-step mediation model depicting the associations between Parent Pain Relief Preferences and the outcome, Long-Term Analgesic Use; Child Profile = Psychologic-Somatic Symptom Cluster. Sobel Test Statistic=2.10;  $p=.036$ .

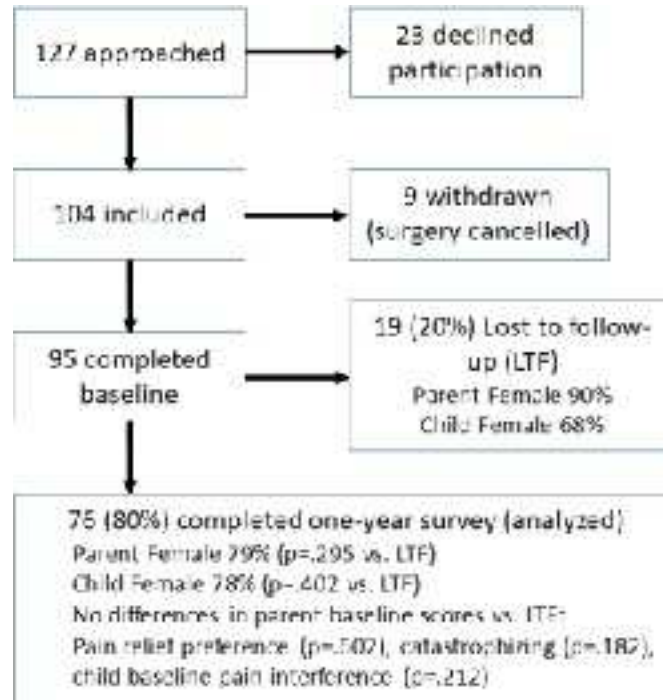
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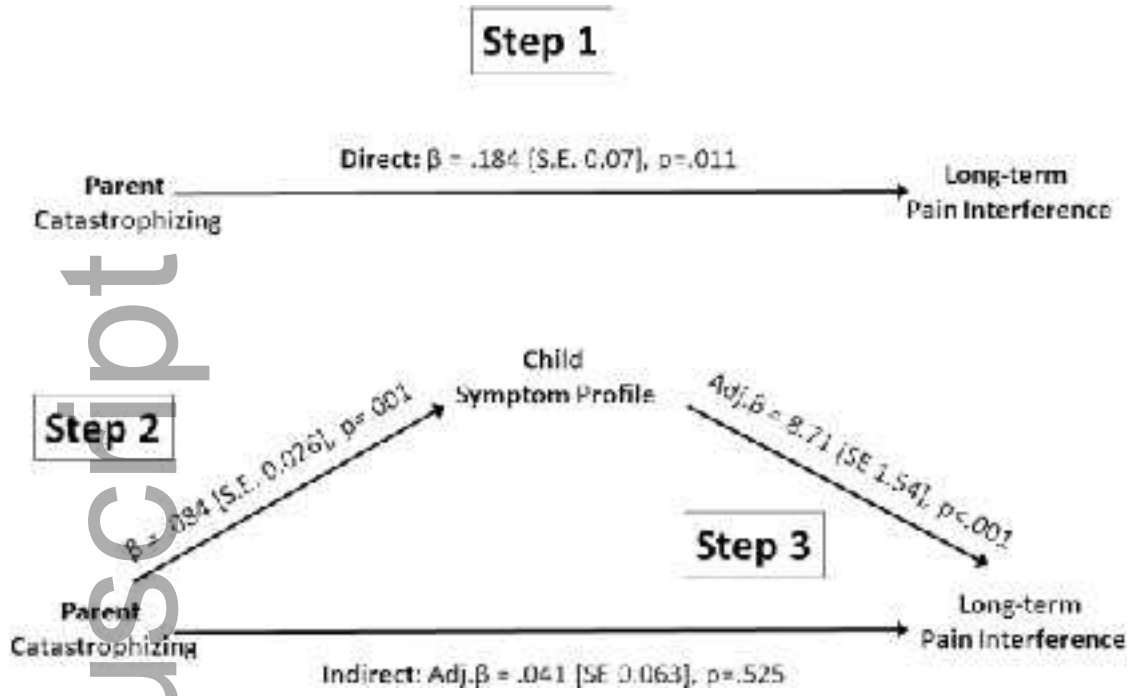
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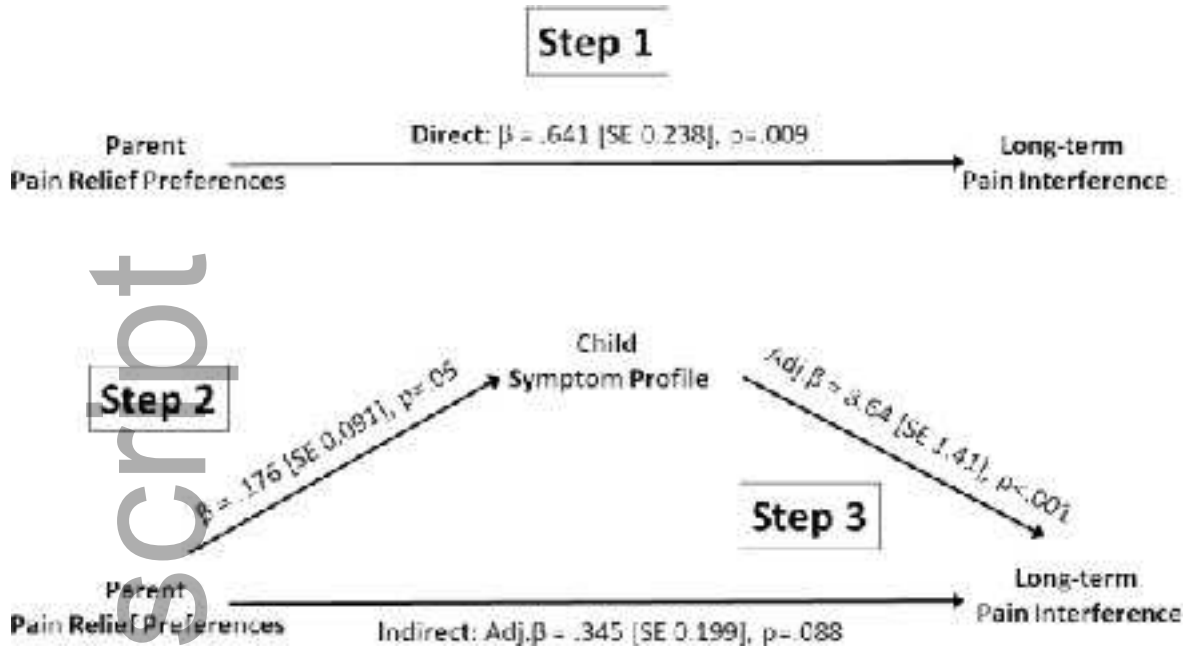


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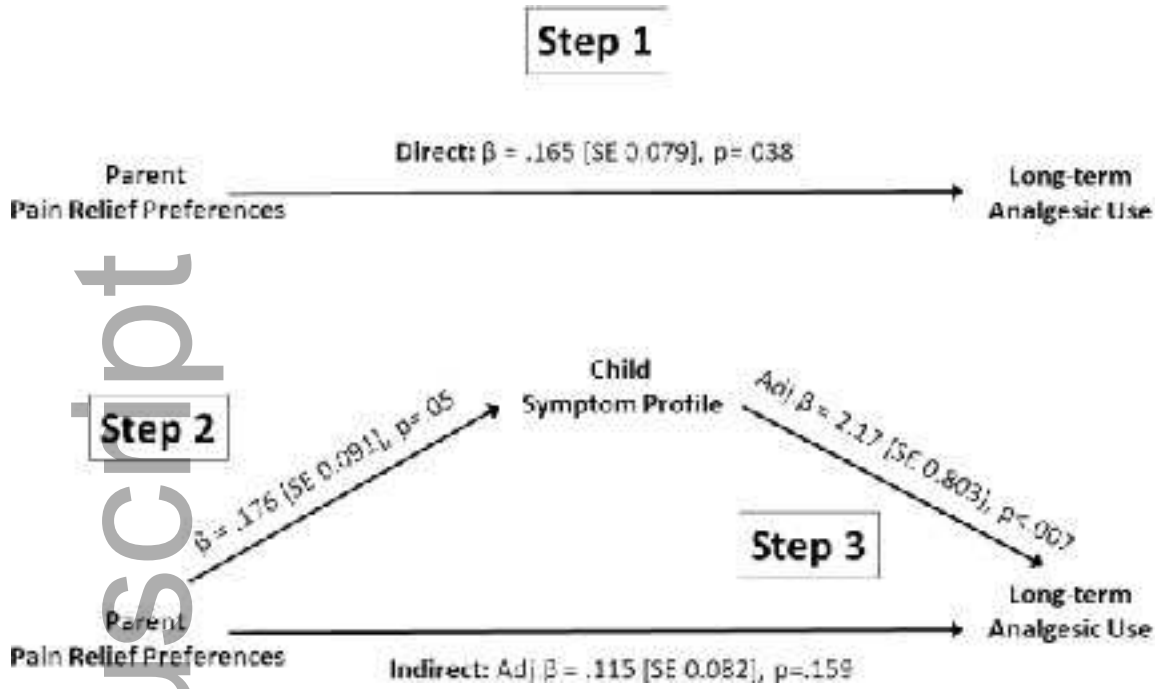


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