Pain Intensity predicts Pain Catastrophizing during the Postpartum Period: A Longitudinal Random Intercept Cross-Lagged Panel study

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Running title: Pain Intensity and Pain Catastrophizing

Abstract

Objective

Pain catastrophizing is an important psychological predictor of pain. Recent evidence suggests the relationship between catastrophizing and pain intensity could be bidirectional, but most studies have been conducted on chronic pain patients and using criticized statistical methods. The present study aimed to examine if the relationship between pain intensity and catastrophizing was bidirectional in the context of childbirth.

Methods

A total of 504 women without chronic pain were recruited on their 32-37 gestational week. They completed measures of catastrophizing and pain intensity on the first encounter and then again at 1, 3, and 6 months postpartum. The temporal relationship between the variables was assessed using a random intercept cross-lagged panel model.

Results

The hypothesis of reciprocal association did not receive support, as pain intensity predicted catastrophizing during the postpartum period, but catastrophizing did not show an effect over pain intensity at any moment.

Conclusions

Pain intensity predicting catastrophizing is consistent with previous literature, while the lack of effect of catastrophizing over pain intensity is an unexpected result, which may suggest that catastrophizing plays a different role in the postpartum period. These results highlight the importance of timely efforts for pain management during the postpartum period and contribute to the theoretical conceptualization of catastrophizing.

Key words

47 Catastrophizing; pain intensity; pregnancy; postpartum; Random intercept cross-lagged panel
48 model

INTRODUCTION

Pain is a subjective experience shaped by biological, psychological, and social factors(1). Among the psychological factors, pain catastrophizing (PC) has received substantial attention in the past two decades, being considered as a prominent predictor of diverse pain outcomes(2), such as pain severity and disability on chronic pain patients(3–5) and persistence of pain and recovery in postoperative settings(6–11).

PC comprises magnification of the painful stimulus threat value, feelings of helplessness, and constant worry about pain(2). According to the Fear and Avoidance Model of pain, people who respond to pain with catastrophic thoughts may develop a series of maladaptive emotions and cognitions towards pain (i.e. fear, anxiety, and hypervigilance), promoting an avoidance behavior which can lead to disuse, disability, depression and, as a consequence, more pain(12). In this model, PC is considered a response to pain; however, research has typically conceptualized it as an enduring personality factor preceding or having a causal influence on the pain experience(13,14).

Only recently, the direction of the relationship between PC and pain intensity (PI) has begun to be tested longitudinally. For instance, clinically significant changes in PC over time predicted subsequent changes in PI and pain interference in patients with chronic musculoskeletal pain(15). Conversely, changes in PI have also shown to predict prospectively subsequent changes in PC(13,16). Consequently, the relationship between PI and PC could be bidirectional.

In fact, five studies have tested this hypothesis using a cross-lagged panel model analysis (CLPM)(17–21). From these five studies, only the most recent of them (and the one with the biggest sample size, N= 538) supported a reciprocal relationship(17). The other four studies did find a prospective influence of PC over PI, but the converse relationship was non-significant. However, the samples used in these studies were relatively small ($n \leq 90$), which renders the test of the hypothesis underpowered. Furthermore, except for one study (conducted with healthy subjects exposed to a painful stimulus)(20), all of them considered patients with chronic pain conditions undergoing multidisciplinary treatments. These patients had likely experienced pain and PC since long before the studies took place, making it difficult to elucidate their temporal relationship. To the best of our knowledge, no studies with acute pain samples have yet been conducted in this regard. Finally, the studies conducted until now have used traditional CLPM, which has been recently criticized(22). Studies examining the relationship between PC and PI need to be conducted using better statistical procedures (i.e., random intercept cross-lagged model) and samples without chronic pain. A better understanding of how these two variables influence each other longitudinally on non-chronic pain patients, not only will contribute to the theoretical framework of PC but will provide insight on the best time to intervene on catastrophic cognitions that may influence the experience of pain.

The context of childbirth is very suitable for studying the temporal relationship between pain and PC. During the prenatal and the postnatal period, women commonly experience different kinds of

pains, and for a considerable percentage of these women (some estimates as high as 22%) the pain may become chronic(23). In this context, PC has shown to predict (i) low back PI during pregnancy(24), (ii) pain anticipation and PI – as well as the request for pain relief – during labor(25,26), (iii) postoperative pain one and two days after cesarean section(27), (iv) perineal pain in the first 24 hours after vaginal delivery(28), and (v) increased risk of persistent postpartum perineal(28) and lumbopelvic pain(29). The influences of PI on PC on the context of childbirth remain to be studied. Therefore, the main goal of the present study was to examine whether the relationship between PI and PC is bidirectional during the perinatal and postpartum periods on women without a history of chronic pain. We expected to find that PI and PC are reciprocally related.

METHODS

Participants and procedure

Between 2017 and 2019, we invited pregnant women attending four medical centers of a university health network in Santiago, Chile to participate in the study. Inclusion criteria were being at 32–37 weeks of gestation of a viable pregnancy, being older than 18, and understanding the Spanish language. Women with a history of chronic pain condition before pregnancy were excluded from the study. Recruitment strategies included research assistants approaching

potential participants in the waiting rooms and dissemination of study information by health professionals and administrative staff. We did not keep a record of the number of pregnant women visiting the four centers during the study period or how many women were invited to the study. Nonetheless, we registered how many women gave their contact to recruiters and staff and accepted to be contacted to receive more information about the study. Of the 882 women who gave their contact information, 57% finally accepted to participate in the study.

After obtaining informed consent, we applied a battery of questionnaires either in a face-to-face interview or via telephone, according to the participant's preferences. We contacted them again by phone at one, three, and six months after childbirth and asked them to complete a shorter set of questionnaires. As an exception, we offer the possibility to complete the questionnaires via email to those participants who were not able to answer by phone; less than 0.7% (n=10) of all the surveys across the waves were completed by this method. Participants received a gift card for 10.000 Chilean pesos (approx. 14 US dollars) at the first assessment and 5.000 Chilean pesos (approx. 7 US dollars) at each follow-up. The study protocol was approved by the ethical committees of the host university and the funding agency.

Figure 1 shows a flow diagram of enrollment, attrition, and drop out at each assessment. At the beginning of the study, 504 participants were recruited and 349 participants (69% of the original sample) provided data at all waves. We had missing data of 1, 87, 68, and 87 participants for the PCS and 2, 87, 69, and 87 participants for the Composed Pain Intensity Index at the first, second,

third, and fourth assessment respectively. The main reason for missing follow-up evaluations was the inability to contact the participants (by phone or email) and only 34 participants (7% of the total sample) refused to continue in the study because of lack of time or interest. Chi-squares test showed that those who completed all the follow-up assessments had a slightly higher educational level than the dropouts ($\chi 2(4)= 14.09$, $p= .007$), but groups were no different in levels of PC (M_{diff} =-0.19, t (283) = -0.18, p =.855) or PI (M_{diff}=-0.02, t (309) = -0.14, p =.887).

Measures

We collected information about demographics, including age, educational level, family income, health care system, number of previous children, and marital status. Type of health care insurance (i.e. public versus private) was used as a proxy for socioeconomic status due to the strong association of these variables in Chile(30). Besides, after childbirth, we asked about the type of delivery and if there was any complication during the pregnancy/delivery or if the newborn presented any health problem at birth.

Composed Pain Intensity Index (31).

We asked participants about the perception of any pain during the last week, regardless of its etiology. Using four items, participants were asked to rate their current, worst, minor, and average pain on scales from 0 (no pain) to 10 (worst pain imaginable). The items were averaged to obtain a composite pain intensity index. This composed index has shown to be a more reliable way of assessing PI than individual numerical rating scales(31).

Pain Catastrophizing Scale (PCS)(32)

The PCS is a 13-item questionnaire that measures catastrophic thoughts and feelings about pain, on a scale from 0 (not at all) to 4 (all the time) (e.g. “I worry all the time about whether the pain will end”, “I become afraid that the pain may get worse”). The original structure(32) comprises three subscales assessing rumination, magnification, and helplessness. The sum of all the items provides a global score on catastrophizing. In the present study, we used only the global score. Higher scores represent greater PC. The Spanish version of the PCS has an adequate internal consistency (Cronbach alpha = 0.79) and test-retest reliability (intraclass correlation coefficient = 0.84)(33). The internal consistency of the scale in our sample was excellent, with Cronbach α ranging from 0.95 to 0.96 on the four assessments.

Data Analytic Plan

To test the bidirectional relation between PC and PI, we estimated a Random Intercept Cross-Lagged Panel Model (RI-CLPM), a type of analysis that overcomes the limitations of the traditional cross-lagged models(22). As demonstrated by Hamaker et al. (22), when estimating the individuals´ rank-order stability of a construct over time, part of this stability is due to stable, trait-like individual characteristics. When estimating regular CLPM, trait-like stability is not accounted for. In contrast, RI-CLPM allows parsing the part of the variability of a measure that is invariant, trait-like, from genuine autoregressive stability, which results in a more precise estimation of the cross-lagged relationships. Additionally, using multigroup analyses we tested the invariance of parameters across the type of health insurance, type of delivery (vaginal versus cesarean), primiparous versus multiparous participants, and pregnancy/delivery complication or newborn health problem. Analyses were run using full information maximum likelihood to make use of all available data. Besides the chi-square, traditional fit indices were used as criteria to determine the fit of the model; including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). Because PC and PI were positively skewed, variables were log-transformed before the analyses.

RESULTS

Descriptive statistics are summarized in Table 1. Women's mean age was 31.2 years (*SD*=5.3; range = 18-44), most of them were in a relationship (94.6%) and had tertiary education (87.7). The participants of our study presented similar characteristics to the women from the metropolitan area of Santiago, with the exception that our sample presented a higher educational level and was married in a greater proportion(34).

Means and correlations between PC and PI scores are presented in Table 2. Except for PC at one month postpartum and PI at six months postpartum, all pairs of variables showed low to moderate significant positive correlations.

RI-CLPM

Figure 2 presents the parameters for the fitted RI-CLPM of PC and PI. The model had a good fit to the data; $\chi^2(9) = 14.59$, $p = 0.10$, CFI=0.99, TLI=0.98, RMSEA= 0.04. The correlation between the trait-like PC and PI latent variables was .48 ($p < .001$), suggesting a moderate association between these two stable characteristics. Autoregressive parameters of both variables were significant except between T1 and T2, showing low to moderate intra-individual stability.

Our results did not support our bidirectional hypothesis, as none of the cross-lagged effects from PC to PI were significant. In contrast, we found a positive and significant effect from PI to PC between T2 and T3 (unstandardized $\beta = 0.24$, $SE = 0.10$, $p = .015$), and between T3 and T4 (unstandardized $\beta = 0.35$, $SE = 0.10$, $p < .001$). No differences were found in autoregressive and

cross-lagged parameters on the separate multi-group analyses by type of health insurance ($\Delta\chi2(\Delta12)$ =13.131, p =.0.360), type of delivery ($\Delta\chi2(\Delta12)$ = 3.818, p =.987), primiparous versus multiparous participants ($\Delta\chi2(\Delta12)$ = 14.943, p =.245), or pregnancy or delivery complication or newborn health problem ($\Delta\chi2(\Delta12)$ = 9.553, p =.655).

DISCUSSION

The present study aimed to test whether the relationship between PC and PI was bidirectional throughout the perinatal and postpartum periods. Our hypotheses were partially supported as PI predicted within-individual changes in PC during the postpartum period, but PC did not predict within-individual changes in PI between any of the adjacent assessment periods.

Our results are in contrast with those reported by Racine et al.(17), who recently found a bidirectional relationship between PC and PI in patients with neuropathic pain. Our findings are also in contrast with the results of several other studies(18,19,21) in which only PC showed to predict PI, but the reverse association was not found. The discrepancies in the results may be related to methodological differences between studies. First, the bidirectionality of the relationship on previous studies was tested using statistical methods that have been widely criticized (i.e., traditional cross-lagged analyses), and may lead to overestimation of the mutual influences between the variables(22). By contrast, our use of RI-CLPM allows us to control for

253 variability due to stable individual characteristics. Specifically, the RI-CLPM model separates the
254 between-person variance through the inclusion of a random intercept, allowing that the lagged
255 relationship actually pertains to within-person dynamics(22). This distinction is especially needed
256 when the stability of the constructs is to some extent of a trait-like, time-invariant nature, like has
257 been suggested for PC(14). Our results show that, although the stable, trait-like PC and PI are
258 moderately correlated, the within-individual PC variability (state-like) does not predict within-
259 individual variability in PI over time.
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262 Second, previous studies were conducted with chronic pain patients(17–19,21) or healthy
263 subjects exposed to a painful stimulus(20). By contrast, we recruited a sample of pregnant
264 women, which did not present chronic pain before their pregnancy, and assessed how PC and PI
265 influenced each other before and after giving birth. To our knowledge, this is the first study
266 testing the mutual influence between PC and PI in the context of childbirth. On one hand, it is
267 possible that the subjective experience of pain during the peri- and the post-natal period, when
268 pain may be expected and normalized and is often associated with a positive outgrowth (the birth
269 of a child), differs from other contexts where pain may be interpreted as a health threat(25). On
270 the other hand, our results may indicate that PC plays a different role in acute pain conditions
271 than in long-term persistent pains. This idea has been previously raised by Buenaver et al.(35)
272 who conceptualizes PC as an inactive factor, which would need to be triggered by a pain
273 condition of a certain duration or severity to exert its adverse influence over PI and other
274 outcomes. This conceptualization is congruent with the results of a systematic review and meta-
275 analysis, which found that the proportion of studies showing a significant association between

preoperative PC (and anxiety) and postoperative chronic pain was larger on the subgroup of musculoskeletal surgery patients, compared with other types of surgeries(6). Also, among musculoskeletal surgery patients, the maximum effect ORs were higher, compared with other types of surgeries(6), which led the authors to argue that, for musculoskeletal patients, pain after surgery may be a perpetuation of preexisting pain rather than the onset of new pain, which could suggest that PC (and anxiety) contribute less to eliciting (emerging) pain than to prolong consolidated pain(6). Similarly, and consistent with our results, Richez et al.(36) examined the role of different psychological predictors on persistent pain at three and six months after cesarean delivery; finding no association between presurgical PC and postsurgical persistent pain on any assessment. The authors compare their results with those reported by Pinto et al. (37) who found that PC predicted postsurgical persistent pain in women undergoing hysterectomy due to benign causes. According to Richez et al. (36), the similarities between both procedures allow suggesting that discrepancies between study findings may be due to differences in the surgical context, including that hysterectomy is often performed on women reporting preoperative pain. Likewise, Olsson et al. (29) found that PC at pregnancy was predictive of lumbopelvic pain at six-month postpartum, but only in participants with lumbopelvic pain present at the pregnancy assessment. Taken together, these studies (including the present work) suggest that the duration of the pain could play an important role in the relationship between PC and pain. This theory will need to be tested with longer longitudinal studies, that could examine if and when the role of catastrophizing changes over the onset of chronic pain.

Regarding autoregressive relationships, the fact that PC in the postpartum period was predicted by PC in the same period, but not by PC before delivery, may suggest that catastrophic thoughts during both periods could be related to different psychological processes. In fact, a post hoc repeated-measure ANOVA analysis showed that PC before delivery was significantly higher than PC on the postpartum period ($F(3, 1041)= 73.35$, $p<0.001$). One possible explanation could be that PC on T1, being evaluated so close to childbirth, may be influenced by apprehensions regarding the delivery process. In order to explore this hypothesis, we ran an additional post hoc analysis to see if PC on T1 correlated with a measure of delivery expectancies in the same period. Specifically, we used four questions rated from 0 to 10, that have shown to predict labor pain in previous works(38, 39): 1)"How anxious are you feeling about your delivery?", 2)"How much pain do you think you will feel during the procedure?", 3) "How much fear do you have of experiencing pain during the delivery or due to your C-section?" and 4) "How much analgesia do you think you will require during and after your delivery?". Previous exploratory factor analysis supported a single factor structure, so we average the items to obtain a global score. This scale showed a positive low correlation with PC ($r= 0.344$, $p<.001$), supporting the idea that PC in this period is related to some extent to anxiety and fears associated with the forthcoming childbirth. This hypothesis should be further examined in future confirmatory studies.

In accordance with our expectations, we found that PI predicted PC during the postpartum period. This result is in line with the findings of numerous longitudinal studies that have supported this relationship throughout the recovery of surgery or injuries(13,17,40,41). However, our prediction that PI assessed during pregnancy will predict within-individual changes in PC at one-month

postpartum was not supported. Interestingly (and similar to what happened with PC), unlike when PI was assessed during the postpartum period, PI at pregnancy was not related to PI assessed one-month after delivery either, suggesting that this variable changed considerably from the prenatal to the postnatal period. This could be explained by the relatively high prevalence of pain experienced during pregnancy compared to the postpartum period(42). A post hoc repeated-measure ANOVA analysis showed that PI before delivery was significantly higher than PI on the postpartum period ($F(3, 1035)= 67.17$, $p<0.001$). Likewise, it is possible that given that pain during pregnancy is more expected than in the postpartum, it could be less linked to catastrophic thoughts during this period.

The results of our study have both, practical and theoretical implications. First, they may suggest that it is important to timely manage pain during the postnatal period. An appropriate pain control could prevent catastrophic thoughts from growing and avoid the entrance on the vicious circle described in the Fear and Avoidance Model(12). This may be especially relevant in the context of childbirth, where the pain is sometimes naturalized(43) and the risk perception of analgesic consumption can be overestimated by both pregnant women and health professionals(44,45).
On the other hand, our results also contribute to a better understanding of the construct of PC and its relationship with PI. Traditionally, PC has been considered as a relatively stable precursor of pain(14). The present research supports the idea that part of the PC variance corresponds to a trait like nature and another part seems to depend on other circumstances, such as PI. Moreover, our findings highlight that the relationship between PC and PI varies throughout different pain

conditions and contexts. The specific factors that may activate PC to play a predictive role over PI remain to be studied.

This study has some limitations. First, we assessed PI regarding any pain reported by the participant. That means that pain referred by some participants could not have been related to pregnancy or postpartum factors and could vary from one assessment to another. Even though "any pain" after childbirth is a common postpartum health problem reported, a study found that perineal pain had a different effect over other pain-related outcomes than "any pain"(46). Therefore, whether the relationship between PC and PI varies among different pains, particularly those related to pregnancy, remains to be studied. Second, our study assessed variables until the first six months postpartum. Future research may examine if the relationship between PC and PI changes beyond that period, being possible that longer pains may activate the adverse effect of PC. Thirdly, we did not keep a record of the number of pregnant women visiting the recruitments centers during the study period or how many women were invited to the study. This limitation must be considered when generalizing the results of the study. Despite this, apart from educational level and marriage, participants of this study presented similar characteristics to the women from the metropolitan area of Santiago. Finally, our sample consists mostly of women from a middle socioeconomic class. Furthermore, we found that participants who missed at least one follow-up assessment had a lower educational level than completers. This limitation is particularly relevant considering that education has been identified as a significant moderator on the relationship between PC and PI(47). Given that the main reason for missing follow-up evaluation was the inability to contact the participant, it is possible that women with a lower

366 educational level had less access to a personal phone. This limitation could be addressed in future
367 longitudinal research by adding additional contact methods as could be network contacts. It
368 remains to be examined if the relationship between PC and PI is replicated in samples of women
369 with a different educational background (lower socioeconomic status).
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372 **Conclusions**
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375 Despite these limitations, the results of the present study support the conclusion that during the
376 postpartum period, changes in PI predict subsequent changes on PC, but this relationship is not
377 reciprocal. The incongruence between these findings and those found in other cross-lagged
378 studies may suggest that the relationship between PC and PI varies depending on the pain
379 characteristics. Finally, these results highlight the importance of timely pain management
380 strategies during the postnatal period, to prevent the growth of catastrophic thoughts and
381 postpartum recovery difficulties.
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Conflict of Interest/disclosure Summary.

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533 **Figure 1.** Study flow diagram. Abbreviations: FU= follow up.

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536 **Figure 2.** Random intercept Cross-Lagged Model of Pain Catastrophizing (PC) and Pain

537 Intensity (PI). Dashed lines indicate non-significant coefficients. Standardized coefficients in

538 parenthesis. All coefficients shown are significant $p < .05$. Abbreviations: PC= Pain

539 catastrophizing, PI = Pain Intensity.