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Key Words:	Infancy and Early Childhood, Parents, Acute Pain, Parent psychosocial functioning

Caregiver Ratings of Toddler Pain: The Role of Caregiver Psychological Predictors

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Author Note

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Abstract

Introduction/Aim: Young children's limited ability to self-report pain necessitates an understanding of the factors that influence pain ratings. The current paper examines the relative prediction of caregiver psychological factors and toddler pain behaviours on caregiver pain ratings post-vaccination.

Methods: One hundred and fifty-six parent-toddler dyads were video recorded during pediatric vaccinations. Child pain behaviours were coded before, during, and after the needle using the Face, Legs, Activity, Cry, Consolability Scale (FLACC; Merkel et al., 2002) and the Neonatal Facial Coding System (NFCS; Grunau & Craig, 1987). Caregivers rated their child's pain after the needle, reported pre- and post-needle worry during the visit, and completed rating scales assessing other areas of psychological functioning within 2 weeks after the appointment. Regression models were estimated to examine the relative contribution of child and caregiver factors to the prediction of caregiver pain ratings.

Results: The regression model predicting caregiver pain ratings from the toddlers' pain-related distress (facial activity immediately after the needle, overall pain-related behaviour immediately after, 1-minute and 2-minutes post-needle) and caregiver worry were significant (adjusted R-square = 0. 21), with caregiver pre- and post-needle worry being the only significant predictors of caregiver pain ratings.

Conclusions: This study outlines that although child distress behaviour remains a significant influence on pain ratings during toddlerhood, when caregiver worry (pre- and post-needle) was entered into the model, they were the only significant predictors of caregiver pain ratings.

Key Words: Infancy and Early Childhood, Parents, Acute Pain, Parent Psychosocial Functioning

Introduction

Caregivers play a crucial role in their young children's experience of pain (Pillai Riddell & Racine, 2009). The Development of Infant Acute Pain Responding- Revised Model (DIAPR-R 2022; Pillai Riddell et al., 2022; see Figure 1) outlines the dyadic feedback loops through which caregivers influence child pain responding. Caregivers' emotional state can trigger their own physiological and cognitive responses to their child's pain-related distress, informing how they assess their child's pain and ultimately the pain-management strategies that they enact. When examining pain assessment, caregiver judgements of their children's pain are critical to understanding children's pain experiences given their limited ability to self-report pain.

Misunderstanding child pain experiences such that caregivers or health care workers over- or under-estimate a child's pain, may impact both development and the care that the child receives. In chronic pain or more repetitive acute pain, inadequate responses to child pain due to misinterpretations of that pain could lead to lifelong psychological and physiological consequences for the child (i.e., abnormal brain development, lower cognitive function, increased pain sensitivity, behavioural problems, coping skills, etc.; Anand et al., 1997; Fitzgerald, 2005; Grunau et al., 2009; Vinall & Grunau, 2014). Moreover, in the acute pain context, underestimating child pain can impact pain management strategies (Pillai Riddell et al., 2022), whereas overestimating and catastrophizing about child pain can increase parents' anxiety also reducing their ability to manage acute pain (Gennis et al., 2018). Thus, caregiver pain judgements are an essential topic to address.

Importantly, research has challenged the accuracy of parental acute pain judgements by illustrating a number of factors, other than child pain behaviour, that can influence their pain ratings (Pillai Riddell et al., 2022). One would assume that parental pain ratings post-

vaccination should be predominantly determined by the child's pain behaviour. However, longitudinal work with infants (Pillai Riddell et al., 2014) and pre-schoolers (Mamedova et al., 2019) showed this was not the case. Infant pain behaviour only explained 18 – 36% of the variance in parental pain ratings and similarly 28% of the variance in parent pain judgments of preschool children (Mamedova et al., 2019). These studies illustrate that there is a substantial amount of variance in parent pain judgments that is still unaccounted for, particularly for young children. Moreover, the steep developmental trajectory in pain responding over the first years of life compels building an understanding of the specific factors that influence parents' pain ratings at various stages of early childhood development (i.e., toddlers).

Furthermore, Mamedova and colleagues (2019) outlined how parental assessment of their own, as well as their child's worry after the needle, predicted pain ratings over and above child pain behaviours. This research is in line with previous research (Akbarzadeh et al., 2018; Bernard & Cohen, 2006), highlighting the importance of accounting for parent psychological variables when investigating factors shaping parent pain judgements. Similarly, previous research also demonstrated that maternal recall of infant pain is impacted more by maternal psychological distress than by child pain behaviour (Pillai Riddell et al., 2007). One particular area of parent psychological functioning that may influence pain ratings is referred to as acculturative stress, which often encapsulates a myriad of stressors that are associated with adjusting to a culture that is different than one's heritage culture (Perreira et al., 2019). According to the Family Stress Model (FSM; Conger et al., 2000), life stressors exerted on parents tend to shape a variety of child outcomes. For example, a recent review paper focusing on acculturative stress and Latinx children outlines how acculturative stress impacts parent emotional distress, disrupts parenting, and compromises family functioning by interfering with

relational dynamics (Miller & Csizmadia, 2022). Any added stress on the caregiver, in this case, acculturative stress, may influence their ability to respond appropriately to the child during a painful procedure. An inability to respond to the child's pain may decrease the caregiver's sense of control, increase their own psychological and physiological responses, and thus impact their assessment of the child's pain. Therefore, it is worth exploring the influence of acculturation as a possible predictor of parent pain ratings due to the potential stressors that accompany it.

The objective of the present study was to examine the relative contributions of child and caregiver factors in predicting caregiver ratings of their children's pain during vaccination in toddlers (18 months and 24 months vaccinations). In addition to studying this phenomenon during an understudied developmental stage of childhood (toddlerhood), the current study goes beyond previous work examining parent pain judgments by collecting samples of parents' subjective reports of the emotional functioning that may be contextualizing their behaviour and pain judgments during the vaccination appointment. Based on previous research, it was hypothesized that, in addition to toddler pain behaviours, measures of caregiver emotional functioning (i.e., worry, psychological distress, acculturation) would relate to the pain rating of their child post-vaccination needle due to the influence of their own physiological and cognitive responses on pain assessment. Given the importance of pain management for children and how caregivers may alter their pain management strategies based on their judgements of the child's pain, the results of this study will elucidate factors that contribute to their ratings of toddler pain after a vaccination needle.

Methods

Participants

The sample included caregiver-toddler dyads recruited from two pediatrician clinics in the greater Toronto area as part of a cohort-sequential longitudinal study during routine vaccination appointments across their second year of life. Data were collected between September 2015 and March 2020. One-hundred and fifty-six dyads participated at one time point between 18 and 24 months of age. To qualify for the study, infants had to be healthy with no chronic illnesses or developmental delays, no previous stays in the neonatal intensive care unit, and born no more than three weeks premature. The primary caregiver had to be fluent in English. The majority of caregivers were mothers who were educated with a university degree or higher. Caregivers were diverse with approximately half the sample reporting a heritage culture of Asian, Latin, Non-European, or Mixed. Toddlers were approximately 57% male and were generally healthy. Table 1 includes demographic information for all participants.

Procedure

The study received approval from York University's Research Ethics Board. Caregivers were approached at their child's routine vaccination appointments to participate in the study. Immediately prior to the vaccination appointment, caregivers completed a participant information sheet (PIS; demographic form) and provided written consent to participate in a naturalistic observational study (minimal interference from research team). Before and after the vaccination procedure, caregivers were asked to rate their own worry. Caregiver pain ratings were collected approximately 3 minutes after the final needle was administered. Caregiver-toddler dyads were videotaped during the immunization appointments for subsequent behavioural coding using the Noldus Observer XT 15.0 software. Within 2 weeks of the study, caregivers were asked to complete standardized questionnaires over the phone examining their

emotional functioning. Toddlers received between 1-3 needles at their appointment, with most of the children receiving only one needle (~60%).

Measures

Caregiver Demographic Information

Prior to the immunization appointment, caregivers were asked to complete a brief demographic questionnaire (Participant Information Sheet; PIS) indicating their relation to the child, self-reported heritage culture (which was subsequently classified by continent or geographic area of origin whenever possible for reporting purposes), highest level of education, and their child's age and sex.

Child Pain

Pain Ratings. Caregivers were asked to rate their child's pain using a numeric rating scale. Immediately after the immunization, parents were asked "On a scale from 0 to 10, how much pain do you think your child experienced?" where 0 indicated "No pain at all" and 10 indicated "The worst possible pain". The 0-10 numeric rating scale (NRS) was also utilized in previous work by Mamedova and colleagues (2019). The inclusion of NRS for child pain and caregiver worry (see below) was based on evidence from previous research outlining the convergent validity between parents' NRS and children's reports (Brudvik et al., 2017).

The Face, Legs, Activity, Cry, Consolability Scale (FLACC). FLACC (Merkel et al., 2002) is a reliable and valid measure of child pain-related behavioural distress between 2 months and 7 years of age. Distress is measured with five types of pain behaviours (face, legs, activity, cry, consolability), each coded on a 0-2 scale in 15-second epochs, resulting in a total score between 0 and 10 for each epoch (with higher scores indicating more child pain). FLACC was coded during four 1-minute periods: one minute before the first needle (pre-needle distress),

immediately after the last needle (reactivity), one minute after the last needle, and two minutes after the last needle. The first 15-seconds of each period was analyzed in the current study to facilitate comparison with previous work. Interrater reliability was obtained with 20% of the data double-coded for reliability, such that 20% of the videos were reviewed and coded by two separate coders to ensure an intra-class correlation coefficient of at least 0.80.

Neonatal Facial Coding System (NFCS). The Neonatal Facial Coding System (Grunau & Craig, 1987) is a well-validated measure used to code infant pain facial expressions including brow bulge, eye squeeze, nasolabial furrow, open lips, vertical stretch mouth, horizontal stretch mouth, and taut tongue. This coding system has been validated for use in neonates (Guinsburg et al., 2000) as well as toddlers (Lilley et al., 1997; Peters et al., 2003). Each facial action is coded second-by-second based on whether the action is present (1) or absent (0). Facial activity was coded for a 10-second epoch before the first needle (baseline), immediately after the last needle, 1-minute after the last needle and 2 minutes after the last needle. Scores were aggregated to create a total facial pain score, where a higher total score indicates more infant pain. Interrater reliability was obtained with 20% of the data coded for reliability, such that 20% of the videos were reviewed and coded by two separate coders to ensure an intra-class correlation coefficient of at least 0.80.

Caregiver Emotional Functioning

Caregiver Worry. Prior to the needle, caregivers were asked "On a scale from 0 to 10, how worried about the needle are you, right now, before the needle, where 0 is 'no worry at all' and 10 is 'the most worry possible'?". Following the final needle, caregivers were then asked, "On a scale from 0 to 10, how worried about the needle are you, right now, after the needle, where 0 is 'no worry at all' and 10 is 'the most worry possible'?".

Brief Symptom Inventory (BSI). The Brief Symptom Inventory (BSI; Derogatis, 1977) is a reliable and valid self-report inventory that consists of 53 items where the individual is asked to rate the extent to which they have been bothered by various domains of psychological functioning within the past week. Responses range from 0 ("not at all") to 4 ("extremely") and they are scaled using the t-score distribution (Mean of 50, Standard Deviation [SD] of 10). The BSI consists of nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. For the current analysis, the Positive Symptom Distress Index score was used to represent overall psychological symptomology/distress over the past week.

Parenting Stress Index (PSI). The Parenting Stress Index (PSI-4; Abidin, 1983) is a reliable and valid measure used to determine the extent of stress within the parent-child dynamic. The PSI-4-SF (short form), utilized in this study, consists of an abbreviated 36-item inventory divided into three domains: Parental Distress (PD), Parent-Child Dysfunctional Interaction (P-CDI), and Difficult Child (DC). Responses are scaled using a t-score distribution. The Parental Distress Score was used to reflect parental perception of their own parenting distress over the past week.

Caregiver Acculturation Ratings. Caregiver acculturation status was explored as an indicator of potential stress, as less identification with mainstream culture, coupled with high identification with heritage culture has been theorized to be a potential stressor (e.g., Berry, 1980). Prior to the appointment, caregivers were asked "On a scale from 0 to 10, where 0 is 'Not at All' and 10 is 'Completely', how much do you feel your way of life reflects your heritage culture?". As added context, the following description of heritage culture was provided to participants, "It may be the culture of your birth, the culture in which you have been raised, or

another culture that forms part of your background. Pick the culture that has influenced you most. If you do not feel that you have been influenced by any other culture, please try to identify the culture that may have had the most impact on previous generations of your family". Caregivers were then asked, "On a scale from 0 to 10, where 0 is 'Not at All' and 10 is 'Completely', how much do you feel your way of life reflects mainstream North American/Canadian culture?". Higher scores reflect greater identification with mainstream or heritage culture.

When possible, caregivers' self-reported heritage culture was coded into the ethnic and cultural categories defined by Statistics Canada (2021), including North American, European, Caribbean, Latin/Central/South American, African, Asian, Oceanian, and Middle Eastern. Not all responses fit into ethnic and cultural categories based on geographic origin. Non-geographic based self-reported ethnic and cultural responses were listed together (e.g., Jewish, Christian, Muslim). Measuring acculturation allows researchers to better understand the extent to which mainstream North American culture and caregivers' own heritage culture are reflected in caregivers' daily lives. It was adapted (see Pillai Riddell et al., 2018) from the Vancouver Index of Acculturation (Ryder et al., 2000) and Berry's (1992) bi-dimensional model of acculturation.

Statistical Analysis Plan

Bivariate correlations between the predictor variables and caregiver pain ratings were examined. Three linear regression models examined each of the clusters of predictors separately (FLACC, NFCS, and caregiver psychological/emotional functioning variables; child sex was used as a covariate) to parsimoniously build a final model that integrated both toddler pain behaviour and parent psychological variables. A final hierarchical linear regression model was estimated to examine the relative contribution of child and caregiver factors to the prediction of

caregiver pain ratings. The fourth and final model included only the significant predictors from the first three models. Child sex was included as a covariate in the first three models because previous research has shown that infant sex predicts parental pain ratings (Moon et al., 2008; Pillai Riddell et al., 2014). However, child sex was not included in the final model as it was not a significant predictor of pain ratings in this sample.

This study experienced missing data across the different variables and this was examined qualitatively. Missing data most often randomly occurred for the child facial coding data due to equipment failure at the clinics. At most, missing NFCS data per time point (pre-needle, post-needles 1,2 and 3) reached 51 (out of 156) missing values (post-needle 2), though the other time points experienced less data loss. In terms of post-visit phone calls, 28 parents were unreachable for the BSI and 22 were missing for the PSI. All other variables experienced less than 10% of data loss. Missing data were handled using pairwise deletion for each analysis. All assumptions for multiple linear regression were tested and met. IBM SPSS Statistics Software (Version 28) was used for all analyses. Power analyses indicated an adequate sample size to achieve 80% power for a medium effect at a significance criterion of $\alpha = .05$. Data available on request.

Results

Means and standard deviations of all variables are included in Tables 2-4, as well as intercorrelations among predictor variables of interest and the outcome (caregiver pain ratings).

Predicting Caregiver Pain Ratings: Models 1-3

Supplementary tables 1-3 present the details of the first three linear regression models predicting caregiver pain ratings from FLACC scores, NFCS scores, and caregiver psychological variables separately. Based on these penultimate models, NFCS Reactivity, FLACC Reactivity,

FLACC Minute 1, FLACC Minute 2, Pre-needle worry, and Post-needle worry were tested in the final model.

Final Model: Predicting Caregiver Pain Ratings with All Significant Predictors

Table 5 presents the details of the final linear regression model predicting caregiver pain ratings using the significant predictors from the first three models. The results of the regression revealed that the model was significant $F(6,107) = 5.95$, $p < .001$, accounting for 20.8% of the variance in caregiver pain ratings. Caregiver psychological variables, namely pre- and post-needle worry, were the only predictors that remained significant ($\beta = .23$, $p < .05$ and $\beta = .21$, $p < .05$ respectively), with more pre- and post-worry indicating higher pain ratings. Steps 1 and 2 in the final model also significantly predicted pain ratings (accounting for 8% and 9% of the variance in pain ratings), with greater behavioural child pain generally predicting a higher caregiver pain rating (with the exception of FLACC minute 1). However, none of these variables independently contributed to the outcome as did pre- and post-needle worry which emerged as unique predictors in the final step.

Discussion

The goal of this study was to examine the relative contributions of child and caregiver factors in predicting caregiver pain ratings during child immunizations over the second year of life. Given the steep developmental trajectory in early childhood, this paper importantly examines predictors of pain ratings in an understudied developmental period (toddlerhood). Further, this research builds on previous studies that outline the significance of infant pain-related distress behaviour on pain ratings (Pillai Riddell et al., 2014) while also expanding on influential caregiver factors previously shown to affect pain ratings in preschool children (Mamedova et al., 2019).

Given that previous research shows that parent ratings of their child's pain do not highly correlate with children's pain scores (Kelly et al., 2002) and that parents tend to underestimate their child's pain (Kamper et al., 2016; St-Laurent-Gagnon et al., 1999), it is essential to outline the factors that influence caregiver pain ratings to ensure appropriate pain management techniques are utilized. The current study found that the final model accounted for 20.8% of the variance in pain ratings. The only predictors that remained significant were caregiver worry prior to and following the needle. In other words, when actual child pain-related distress behaviour (both fine-grained facial action units and more gross body movements) were put in the model, caregiver worry variables accounted for unique variance in pain ratings, while child behaviours dropped out of the model as non-significant predictors. As mentioned earlier, the dyadic feedback loop through which caregivers influence child pain responding is emphasized by the Development of Infant Acute Pain Responding- Revised Model (DIAPR-R; Pillai Riddell et al., 2022). As such, the findings of this study lend support to the DIAPR-R 2022 model, which outlines how caregivers' own internal factors significantly influences their interpretation of the pain, beyond the child's actual pain behaviour. This study adds further credence to a significant concern in pediatric medicine that children's pain care is predicated on proxy ratings that have been shown in numerous studies to under- or overestimate child reports, or not be significantly related to the child's pain-related distress behaviour. It is particularly important for young children who are not yet capable of self-report.

This research underscores the importance of paying attention to the caregiver context and managing caregivers' anxieties and worries during painful medical procedures. Even beyond influencing pain judgements and pain care, studies show that parental anxiety significantly predicts child pain and anxiety during medical events (Anthony et al., 2011; Jacobsen et al.,

1990), with one study specifically reporting that parent anxiety prior to pediatric immunizations significantly correlated with measures of infant distress during the immunization (Bernard & Cohen, 2006). Another study found that the relationship between parent preprocedural anxiety and child pain was mediated by children's procedural anxiety, such that the preprocedural anxiety of the parent inadvertently influenced procedural anxiety within the child which, in turn, increased the child's pain (Bearden et al., 2012). The current study's measure of worry asked about the caregivers' worry in relation to the needle, which may encompass several concerns surrounding the immunization. For example, parents may be worried about the child's reaction to the needle, both emotionally and physically (i.e., side effects). They may also harbour negative beliefs about vaccines or concerns surrounding the administration of the needle. Thus, all these worries surrounding their child's vaccination may accumulate and ultimately impact their responses before, during, and after the immunization. Therefore, it is essential that caregivers are able to manage their own stress in order to prevent adding any additional stress to the child. It should also be noted that in this sample, levels of worry and pain ratings were generally low during these visits. This may be due to the toddlers' age, as both children and caregivers would have had previous experiences with immunizations during infancy. Consequently, this research should be reproduced in more stressful environments such as hospital settings.

Although our final model did not find a significant relationship between broader emotional functioning (i.e., outside the immediate immunization appointment) and caregiver pain ratings, in the steps leading up to the final model, an interesting exploratory bivariate relationship was elucidated. The relationship with the mainstream acculturation variable was seen in the predicted direction (i.e., the more an individual reported they identified with mainstream culture, the lower the pain scores). It is well-known in the literature that different

ethnic or cultural groups employ different parenting styles (Kotchick & Forehand, 2002) and thus may enact different behavioural responses to child pain. For example, one study found that caregivers who self-identified highly with individualist heritage cultures tended to show greater emotional availability, which in turn predicted lower pain scores for infants (O'Neill et al., 2016). Considering this effect on parental behaviour, cultural identification or level of acculturation may also impact caregiver pain ratings. For example, in this sample, higher identification with mainstream culture may indicate less stress associated with acculturation allowing for an effective behavioural response to the child and in turn, a lower pain rating. Ultimately, a reduction in stress in any manner, related to acculturation or any other factor that may increase parent stress during a distressing child event such as vaccination, may allow caregivers to respond more appropriately to their child's pain.

From the DIAPR-R 2022 model perspective, the dyadic feedback loops between parent responses to child pain strongly emphasize the interconnections between the parent and the child in the context of child pain. Therefore, since parent mental health has been found to influence parent responsiveness to child pain (i.e., parents with depressive symptoms engage in more protective and catastrophizing responses to child pain; Fussner et al., 2018), it seems reasonable to suggest that their ability to appropriately recognize the level of their child's pain would also be impacted by emotional functioning. Future research should continue to explore the impact of stress and other mental health factors that may impact caregivers' ability to interpret and respond to their children's pain. Another area for future research is the potential role that parental locus of control over their child's pain may play in their worry about their child's pain, their pain ratings, and the pain-soothing behaviours they enact. Additionally, more research is needed to specifically analyze the effect of caregiver pain schemas on the particular pain management

strategies that they choose to enact, such as topical anesthetics, distraction, and comfort (Chou et al., 2012; Pillai Riddell et al., 2023; Trottier et al., 2019). Research shows that these strategies are effective in reducing pain in children. According to the DIAPR-R 2022 model, the caregiver's pain management techniques depend on their assessment of the child's pain; greater interpretation of pain may lead to an increase in soothing behaviours and lower assessment of pain may lead to less soothing behaviours, which may in turn impact the child's pain behaviours. Therefore, assessment of pain schemas and pain management strategies can reciprocally influence one another and should further be analyzed concurrently. The current study does not focus on specific pain management strategies nor does it touch upon the physiological consequences for caregivers during child pain and thus cannot make any conclusions regarding these important aspects of the DIAPR-R 2022 model. Finally, further to the use of our measure of acculturation, while based on a strong theoretical framework, more work must be done to validate a measure of acculturative stress that can be feasibly used in primary care settings.

In terms of limitations, several caveats must be discussed. The generalizability of the study results may be affected by the caregivers' high education level, English proficiency (which would reduce acculturation variability in our sample), as well as our inclusion of only healthy full-term toddlers. This may limit generalizing to individuals of lower education status and children who have experienced greater pain in early infancy such as children who were born premature, have had previous stays in the NICU and have chronic conditions or developmental delays. Moreover, our team did not report race and ethnicity data but chose to ask participants to report the heritage culture(s) that have influenced their way of life most and then how much both their self-reported heritage culture and mainstream North American/Canadian culture influenced their daily lives. This was done to get a sense of acculturative stress. The construct of

acculturative stress was based on Berry's classic bi-dimensional model (Berry, 1992), and while a more restrictive construct, was considered more appropriate for our research focus. As explained earlier, acculturative stress serves as a hypothesized direct mechanism of *how* culture would impact pain judgments. From our perspective, race and ethnicity are context-bound terms that often vary in operationalization by both research participants and researchers. Moreover, how race and ethnicity would link to pain judgements is more complex and indirect. However, it is recognized that this makes it more difficult to generalize to studies that use race and ethnicity to describe their participants and more work must be done due to evolving flaws in the bi-dimensional model that do not account for the complexity of acculturation today (e.g., multiple-stop migration/refugee journeys; routine access to other cultural influences from increased travel and easy access to international movies, television/streaming shows, and music).

This study has important clinical implications that should be noted. Given how caregivers' interpretation of their child's pain may impact their ability to respond to their child's pain, it is essential that any factors that impact their pain assessments be addressed and managed. As such, based on the study results, medical professionals are encouraged to be attentive to caregivers who may present signs of worry and should attempt to alleviate their worry by answering any questions they have, building their confidence with pain management techniques, or addressing specific concerns they may have about the pain or the vaccination itself. In addition, it may be helpful to inform caregivers about what to expect during their child's painful procedure to ensure they are better prepared and can regulate their own emotional state, particularly for new parents who may not know what to expect. Specifically, educating caregivers on expectations surrounding a painful experience at key developmental periods of a child's life may reduce internal stress and allow them to focus more on external indicators (i.e.,

child's behaviour) when assessing their child's level of pain. Medical professionals working with young children, particularly those incapable of self-report, may want to consider care for young children as a dyadic context. By focusing on the parent (e.g., alleviating worry) they will likely be able to improve medical care for the young child.

In conclusion, this study highlights the importance of considering the various factors that may be influencing caregivers' ratings of their child's pain at different developmental stages. It is especially important to analyze these factors with younger children (infants and toddlers) who are unable to verbally communicate their pain and whose parents' pain ratings hold even more weight. Given the potentially lasting effects of inadequate pain management, it is essential to accurately assess and react to child pain, especially in the context of child vaccinations which are common routine appointments for young children. This study found that beyond the contribution of child pain-related distress behaviours, caregiver worry plays a significant role in determining caregivers' ratings of their child's pain. In fact, worry (pre and post) contributed more to pain ratings than peak distress pain behaviours of the child. These findings lend support to the DIAPR-R 2022 model by highlighting the influence of caregiver factors on their appraisal of their child's pain and adding results from a new developmental period to the existing literature. Future research should build on these findings by examining additional variables that may influence caregiver ratings of child pain as well as understanding these relationships at other key developmental stages.

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References

Abidin, R. R. (1983). *The Parenting Stress Index*. Pediatric Psychology Press.

Akbarzadeh, G., Daniali, H., Javdzadh, M., Caes, L., Ranjbar, S., & Habibi, M. (2018). The relationship of parental pain catastrophizing with parents reports of children's anxiety, depression, and headache severity. *Iranian Journal of Child Neurology*, *12*(1), 55–66.

Anand, K.S., Grunau, R. E., & Oberlander, T.F. (1997). Developmental character and long-term consequences of pain in infants and children. *Pain Management in Children, 6*(4), 703-724. https://doi.org/10.1016/S1056-4993(18)30274-8.

Anthony, K. K., Bromberg, M. H., Gil, K. M., & Schanberg, L. E. (2011). Parental perceptions of child vulnerability and parent stress as predictors of pain and adjustment in children with chronic arthritis. *Children's Health Care, 40*(1), 53-69. DOI: 10.1080/02739615.2011.537938

Bearden, D. J., Feinstein, A., & Cohen, L. L. (2012). The influence of parent preprocedural anxiety on child procedural pain: Mediation by child procedural anxiety. *Journal of Pediatric Psychology*, *37*(6), 680–686, https://doi.org/10.1093/jpepsy/jss041

Bernard, R., & Cohen, L. (2006). Parent anxiety and infant pain during pediatric immunizations. *Journal of Clinical Psychology in Medical Settings,13*(3), 285–290. https://doi.org/10.1007/s10880-006-9027-6

Berry, J.W. (1980). Acculturation as varieties of adaptation. In: A.M. Padilla (Eds.), *Acculturation: Theory, models, and some new findings* (pp. 9-25). Boulder, CO: Westview.

Berry, J. W. (1992). Acculturation and adaptation in a new society. *International migration*, *30*, 69-69.

Brudvik, C., Mouette, S-V., Baste, V., & Morken, T. (2017). A comparison of pain assessment by physician's, parent's, and children in an outpatient setting. *Emergency Medicine Journal, 34*(3), 138-144. https://doi.org/10.1136/emermed-2016-205825

Chou, Y. C., Yip, W. H., Chang, L. Y., & Lin, C. H. (2012). Reducing neonatal vaccination pain: The effectiveness of behavioral interventions. *Journal of Nursing & Healthcare Research*, *8*(1).

Conger, K. J., Rueter, M. A., & Conger, R. D. (2000). The role of economic pressure in the lives of parents and their adolescents: The family stress model. In L. Crockett & R. Silbereisen (Eds.), Negotiating adolescence in times of social change (pp. 201–233). Cambridge University Press

Derogatis, L. R. (1975). *Brief Symptom Inventory*. Baltimore, MD: Clinical Psychometric Research.

Fitzgerald, M. (2005). The development of nociceptive circuits. *Nature Reviews Neuroscience, 6*, 507–520. https://doi.org/10.1038/nrn1701

Fussner, L. M., Schild, C., Holley, A. L., & Wilson, A. C. (2018). Parent chronic pain and mental health symptoms impact responses to children's pain. *Canadian Journal of Pain*, *2*(1), 258–265. https://doi.org/10.1080/24740527.2018.1518119

Gennis, H., Pillai Riddell, R., O'Neil, M., Katz, J., Taddio,. A., Garfield, H., & Greenberg, S. (2018). Parental psychological distress moderates the impact of a video intervention to help parents manage young child vaccination pain, *Journal of Pediatric Psychology*, 43 (10)1170–1178, https://doi.org/10.1093/jpepsy/jsy058

Grunau, R., & Craig, K. D. (1987). Pain expression in neonates: Facial action and cry. *Pain*, *28*(3), 395–410. https://doi.org/10.1016/0304-3959(87)90073-X

Grunau, R. E., Whitfield, M. F., Petrie-Thomas, J., Synnes, A. R., Cepeda, I. L., Keidar, A., Rogers, M., Mackay, M., Hubber-Richard, P., & Johannesen, D. (2009). Neonatal pain, parenting stress and interaction, in relation to cognitive and motor development at 8 and 18 months in preterm infants. *Pain*, *143*(1-2), 138–146. https://doi.org/10.1016/j.pain.2009.02.014

Guinsburg, R., de Araújo Peres, C., Branco de Almeida, M. F., de Cássia Xavier Balda, R., Cássia Berenguel, R., Tonelotto, J., & Kopelman, B. I. (2000). Differences in pain expression between male and female newborn infants. *Pain*, *85*(1-2), 127–133. https://doi.org/10.1016/s0304-3959(99)00258-4

Jacobsen, P. B., Manne, S. L., Gorfinkle, K., & Schorr, O. (1990). Analysis of child and parent behavior during painful medical procedures. *Health Psychology, 9*, 559–576.

Kamper, S. J., Dissing, K. B., & Hestbaek, L. (2016). Whose pain is it anyway? Comparability of pain reports from children and their parents. *Chiropractic & Manual Therapies*, *24*, 24. https://doi.org/10.1186/s12998-016-0104-0

Kelly, A. M., Powell, C. V., & Williams, A. (2002). Parent visual analogue scale ratings of children's pain do not reliably reflect pain reported by child. *Pediatric Emergency Care*, *18*(3), 159–162. https://doi.org/10.1097/00006565-200206000-00002

Kotchick, B.A., & Forehand, R. (2002). Putting parenting in perspective: A discussion of the contextual factors that shape parenting practices. *Journal of Child and Family Studies, 11*, 255–269. https://doi.org/10.1023/A:1016863921662

Lilley, C. M., Craig, K. D., & Grunau, R. E. (1997). The expression of pain in infants and toddlers: developmental changes in facial action. *Pain*, *72*(1-2), 161–170. https://doi.org/10.1016/s0304-3959(97)00034-1

Mamedova, K., Pillai Riddell, R. R., DiLorenzo, M. G., Flora, D. B., Garfield, H., & Greenberg, S. (2019). Parental report of self and child worry during acute pain: A critical factor in determining parental pain judgment. *The Clinical Journal of Pain*, *35*(8), 696–702. https://doi.org/10.1097/AJP.0000000000000731

Merkel, S., Voepel-Lewis, T., & Malviya, S. (2002). Pain assessment in infants and young children: The FLACC scale. *American Journal of Nursing, 102*(10), 55–8. 10.1097/00000446-200210000-00024

Miller, M., & Csizmadia, A. (2022). Applying the family stress model to parental acculturative stress and Latinx youth adjustment: A review of the literature. *Journal of Family Theory & Review*, *14*(2), 275–293. https://doi.org/10.1111/jftr.12448

Moon, E. C., Chambers, C. T., Larochette, A. C., Hayton, K., Craig, K. D., & McGrath, P. J. (2008). Sex differences in parent and child pain ratings during an experimental child pain task. *Pain Research & Management*, *13*(3), 225–230. https://doi.org/10.1155/2008/457861

O'Neill, M. C., Pillai Riddell, R., Garfield, H., & Greenberg, S. (2016). Does caregiver behavior mediate the relationship between cultural individualism and infant pain at 12 months of age? *The Journal of Pain*, *17*(12), 1273–1280. https://doi.org/10.1016/j.jpain.2016.08.008

Perreira, K. M., Marchante, A. N., Schwartz, S. J., Isasi, C. R., Carnethon, M. R., Corliss, H. L., Kaplan, R. C., Santisteban, D. A., Vidot, D. C., van Horn, L., & Delamater, A. M. (2019). Stress and resilience: Key correlates of mental health and substance use in the Hispanic community health study of Latino youth. *Journal of Immigrant and Minority Health, 21*(1), 4–13. https://doi.org/10.1007/s10903-018-0724-7

Peters, J. W., Koot, H. M., Grunau, R. E., de Boer, J., van Druenen, M. J., Tibboel, D., & Duivenvoorden, H. J. (2003). Neonatal Facial Coding System for assessing postoperative pain in infants: Item reduction is valid and feasible. *The Clinical Journal of Pain*, *19*(6), 353–363. https://doi.org/10.1097/00002508-200311000-00003

Pillai Riddell, R., Bucsea, O., Shiff, I., Chow, C., Gennis, H.G., Badovinac, S., DiLorenzo-Klas, M., Racine, N.M., Ahola Kohut, S., Lisi, D., Turcotte, K., Stevens, B., & Uman, L.S. (2023). Non-pharmacological management of infant and young child procedural pain. *Cochrane Database of Systematic Reviews, 6*. Art. No.: CD006275. DOI: 10.1002/14651858.CD006275.pub4.

Pillai Riddell, R., Flora, D.B., Stevens, S.A., Greenberg, S., & Garfield, H. (2014). The role of infant pain behaviour in predicting parent pain ratings. *Pain Research and Management*, *19*(5): e124-32. doi:/10.1155/2014/934831

Pillai Riddell, R., Jasim, S., & Hamwi, L. (2022). Out of the mouth of babes: A lot about pain has nothing to do with pain. *Pain, 163*, S117-S125. https://doi: 10.1097/j.pain.0000000000002761

Pillai Riddell, R., O'Neill, M. C., Campbell, L., Taddio, A., Greenberg, S., & Garfield, H. (2018). Featured article: The ABCDs of pain management: A double-blind randomized controlled trial examining the impact of a brief educational video on infants' and toddlers' pain scores and parent soothing behavior. *Journal of Pediatric Psychology*, *43*(3), 224–233. https://doi.org/10.1093/jpepsy/jsx122

Pillai Riddell, R., Racine, N. (2009). Assessing pain in infancy: The caregiver context. *Journal of Pain Research and Management*,*14*, 27-32. doi:10.1155/201/410725

Pillai Riddell, R. R., Stevens, B. J., Cohen, L. L., Flora, D. B., & Greenberg, S. (2007). Predicting maternal and behavioral measures of infant pain: The relative contribution of maternal factors. *Pain*, *133*(1-3), 138–149. https://doi.org/10.1016/j.pain.2007.03.020

Ryder, A. G., Alden, L. E., & Paulhus, D. L. (2000). Is acculturation unidimensional or bidimensional? A head-to-head comparison in the prediction of personality, self-identity, and adjustment. *Journal of Personality and Social Psychology*, *79*(1), 49–65. https://doi.org/10.1037//0022-3514.79.1.49

Statistics Canada (2021). *List of ethnic or cultural origins 2021*. https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1310929

St-Laurent-Gagnon, T., Bernard-Bonnin, A. C., & Villeneuve, E. (1999). Pain evaluation in preschool children and by their parents. *Acta Paediatrica (Oslo, Norway : 1992)*, *88*(4), 422–427. https://doi.org/10.1080/08035259950169819

Trottier, E. D., Doré-Bergeron, M. J., Chauvin-Kimoff, L., Baerg, K., & Ali, S. (2019). Managing pain and distress in children undergoing brief diagnostic and therapeutic procedures. *Paediatrics & Child Health*, *24*(8), 509–535. https://doi.org/10.1093/pch/pxz026

Vinall, J., & Grunau, R. (2014). Impact of repeated procedural pain-related stress in infants born very preterm. *Pediatric Research, 75*, 584–587. https://doi.org/10.1038/pr.2014.16

Caregiver Ratings of Toddler Pain: The Role of Caregiver Psychological Predictors

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Abstract

Introduction/Aim: Young children's limited ability to self-report pain necessitates an understanding of the factors that influence pain ratings. The current paper examines the relative prediction of caregiver psychological factors and toddler pain behaviours on caregiver pain ratings post-vaccination.

Methods: One hundred and fifty-six parent-toddler dyads were video recorded during pediatric vaccinations. Child pain behaviours were coded before, during, and after the needle using the Face, Legs, Activity, Cry, Consolability Scale (FLACC; Merkel et al., 2002) and the Neonatal Facial Coding System (NFCS; Grunau & Craig, 1987). Caregivers rated their child's pain after the needle, reported pre- and post-needle worry during the visit, and completed rating scales assessing other areas of psychological functioning within 2 weeks after the appointment. Regression models were estimated to examine the relative contribution of child and caregiver factors to the prediction of caregiver pain ratings.

Results: The regression model predicting caregiver pain ratings from the toddlers' pain-related distress (facial activity immediately after the needle, overall pain-related behaviour immediately after, 1-minute and 2-minutes post-needle) and caregiver worry were significant (adjusted R-square = 0. 21), with caregiver pre- and post-needle worry being the only significant predictors of caregiver pain ratings.

Conclusions: This study outlines that although child distress behaviour remains a significant influence on pain ratings during toddlerhood, when caregiver worry (pre- and post-needle) was entered into the model, they were the only significant predictors of caregiver pain ratings.

Key Words: Infancy and Early Childhood, Parents, Acute Pain, Parent Psychosocial Functioning

Introduction

Caregivers play a crucial role in their young children's experience of pain (Pillai Riddell & Racine, 2009). The Development of Infant Acute Pain Responding- Revised Model (DIAPR-R 2022; Pillai Riddell et al., 2022; see Figure 1) outlines the dyadic feedback loops through which caregivers influence child pain responding. Caregivers' emotional state can trigger their own physiological and cognitive responses to their child's pain-related distress, informing how they assess their child's pain and ultimately the pain-management strategies that they enact. When examining pain assessment, caregiver judgements of their children's pain are critical to understanding children's pain experiences given their limited ability to self-report pain.

Misunderstanding child pain experiences such that caregivers or health care workers over- or under-estimate a child's pain, may impact both development and the care that the child receives. In chronic pain or more repetitive acute pain, inadequate responses to child pain due to misinterpretations of that pain could lead to lifelong psychological and physiological consequences for the child (i.e., abnormal brain development, lower cognitive function, increased pain sensitivity, behavioural problems, coping skills, etc.; Anand et al., 1997; Fitzgerald, 2005; Grunau et al., 2009; Vinall & Grunau, 2014). Moreover, in the acute pain context, underestimating child pain can impact pain management strategies (Pillai Riddell et al., 2022), whereas overestimating and catastrophizing about child pain can increase parents' anxiety also reducing their ability to manage acute pain (Gennis et al., 2018). Thus, caregiver pain judgements are an essential topic to address.

Importantly, research has challenged the accuracy of parental acute pain judgements by illustrating a number of factors, other than child pain behaviour, that can influence their pain ratings (Pillai Riddell et al., 2022). One would assume that parental pain ratings post-

vaccination should be predominantly determined by the child's pain behaviour. However, longitudinal work with infants (Pillai Riddell et al., 2014) and pre-schoolers (Mamedova et al., 2019) showed this was not the case. Infant pain behaviour only explained 18 – 36% of the variance in parental pain ratings and similarly 28% of the variance in parent pain judgments of preschool children (Mamedova et al., 2019). These studies illustrate that there is a substantial amount of variance in parent pain judgments that is still unaccounted for, particularly for young children. Moreover, the steep developmental trajectory in pain responding over the first years of life compels building an understanding of the specific factors that influence parents' pain ratings at various stages of early childhood development (i.e., toddlers).

Furthermore, Mamedova and colleagues (2019) outlined how parental assessment of their own, as well as their child's worry after the needle, predicted pain ratings over and above child pain behaviours. This research is in line with previous research (Akbarzadeh et al., 2018; Bernard & Cohen, 2006), highlighting the importance of accounting for parent psychological variables when investigating factors shaping parent pain judgements. Similarly, previous research also demonstrated that maternal recall of infant pain is impacted more by maternal psychological distress than by child pain behaviour (Pillai Riddell et al., 2007). One particular area of parent psychological functioning that may influence pain ratings is referred to as acculturative stress, which often encapsulates a myriad of stressors that are associated with adjusting to a culture that is different than one's heritage culture (Perreira et al., 2019). According to the Family Stress Model (FSM; Conger et al., 2000), life stressors exerted on parents tend to shape a variety of child outcomes. For example, a recent review paper focusing on acculturative stress and Latinx children outlines how acculturative stress impacts parent emotional distress, disrupts parenting, and compromises family functioning by interfering with

relational dynamics (Miller & Csizmadia, 2022). Any added stress on the caregiver, in this case, acculturative stress, may influence their ability to respond appropriately to the child during a painful procedure. An inability to respond to the child's pain may decrease the caregiver's sense of control, increase their own psychological and physiological responses, and thus impact their assessment of the child's pain. Therefore, it is worth exploring the influence of acculturation as a possible predictor of parent pain ratings due to the potential stressors that accompany it.

The objective of the present study was to examine the relative contributions of child and caregiver factors in predicting caregiver ratings of their children's pain during vaccination in toddlers (18 months and 24 months vaccinations). In addition to studying this phenomenon during an understudied developmental stage of childhood (toddlerhood), the current study goes beyond previous work examining parent pain judgments by collecting samples of parents' subjective reports of the emotional functioning that may be contextualizing their behaviour and pain judgments during the vaccination appointment. Based on previous research, it was hypothesized that, in addition to toddler pain behaviours, measures of caregiver emotional functioning (i.e., worry, psychological distress, acculturation) would relate to the pain rating of their child post-vaccination needle due to the influence of their own physiological and cognitive responses on pain assessment. Given the importance of pain management for children and how caregivers may alter their pain management strategies based on their judgements of the child's pain, the results of this study will elucidate factors that contribute to their ratings of toddler pain after a vaccination needle.

Methods

Participants

The sample included caregiver-toddler dyads recruited from two pediatrician clinics in the greater Toronto area as part of a cohort-sequential longitudinal study during routine vaccination appointments across their second year of life. Data were collected between September 2015 and March 2020. One-hundred and fifty-six dyads participated at one time point between 18 and 24 months of age. To qualify for the study, infants had to be healthy with no chronic illnesses or developmental delays, no previous stays in the neonatal intensive care unit, and born no more than three weeks premature. The primary caregiver had to be fluent in English. The majority of caregivers were mothers who were educated with a university degree or higher. Caregivers were diverse with approximately half the sample reporting a heritage culture of Asian, Latin, Non-European, or Mixed. Toddlers were approximately 57% male and were generally healthy. Table 1 includes demographic information for all participants.

Procedure

The study received approval from York University's Research Ethics Board. Caregivers were approached at their child's routine vaccination appointments to participate in the study. Immediately prior to the vaccination appointment, caregivers completed a participant information sheet (PIS; demographic form) and provided written consent to participate in a naturalistic observational study (minimal interference from research team). Before and after the vaccination procedure, caregivers were asked to rate their own worry. Caregiver pain ratings were collected approximately 3 minutes after the final needle was administered. Caregiver-toddler dyads were videotaped during the immunization appointments for subsequent behavioural coding using the Noldus Observer XT 15.0 software. Within 2 weeks of the study, caregivers were asked to complete standardized questionnaires over the phone examining their

emotional functioning. Toddlers received between 1-3 needles at their appointment, with most of the children receiving only one needle (~60%).

Measures

Caregiver Demographic Information

Prior to the immunization appointment, caregivers were asked to complete a brief demographic questionnaire (Participant Information Sheet; PIS) indicating their relation to the child, self-reported heritage culture (which was subsequently classified by continent or geographic area of origin whenever possible for reporting purposes), highest level of education, and their child's age and sex.

Child Pain

Pain Ratings. Caregivers were asked to rate their child's pain using a numeric rating scale. Immediately after the immunization, parents were asked "On a scale from 0 to 10, how much pain do you think your child experienced?" where 0 indicated "No pain at all" and 10 indicated "The worst possible pain". The 0-10 numeric rating scale (NRS) was also utilized in previous work by Mamedova and colleagues (2019). The inclusion of NRS for child pain and caregiver worry (see below) was based on evidence from previous research outlining the convergent validity between parents' NRS and children's reports (Brudvik et al., 2017).

The Face, Legs, Activity, Cry, Consolability Scale (FLACC). FLACC (Merkel et al., 2002) is a reliable and valid measure of child pain-related behavioural distress between 2 months and 7 years of age. Distress is measured with five types of pain behaviours (face, legs, activity, cry, consolability), each coded on a 0-2 scale in 15-second epochs, resulting in a total score between 0 and 10 for each epoch (with higher scores indicating more child pain). FLACC was coded during four 1-minute periods: one minute before the first needle (pre-needle distress),

immediately after the last needle (reactivity), one minute after the last needle, and two minutes after the last needle. The first 15-seconds of each period was analyzed in the current study to facilitate comparison with previous work. Interrater reliability was obtained with 20% of the data double-coded for reliability, such that 20% of the videos were reviewed and coded by two separate coders to ensure an intra-class correlation coefficient of at least 0.80.

Neonatal Facial Coding System (NFCS). The Neonatal Facial Coding System (Grunau & Craig, 1987) is a well-validated measure used to code infant pain facial expressions including brow bulge, eye squeeze, nasolabial furrow, open lips, vertical stretch mouth, horizontal stretch mouth, and taut tongue. This coding system has been validated for use in neonates (Guinsburg et al., 2000) as well as toddlers (Lilley et al., 1997; Peters et al., 2003). Each facial action is coded second-by-second based on whether the action is present (1) or absent (0). Facial activity was coded for a 10-second epoch before the first needle (baseline), immediately after the last needle, 1-minute after the last needle and 2 minutes after the last needle. Scores were aggregated to create a total facial pain score, where a higher total score indicates more infant pain. Interrater reliability was obtained with 20% of the data coded for reliability, such that 20% of the videos were reviewed and coded by two separate coders to ensure an intra-class correlation coefficient of at least 0.80.

Caregiver Emotional Functioning

Caregiver Worry. Prior to the needle, caregivers were asked "On a scale from 0 to 10, how worried about the needle are you, right now, before the needle, where 0 is 'no worry at all' and 10 is 'the most worry possible'?". Following the final needle, caregivers were then asked, "On a scale from 0 to 10, how worried about the needle are you, right now, after the needle, where 0 is 'no worry at all' and 10 is 'the most worry possible'?".

Brief Symptom Inventory (BSI). The Brief Symptom Inventory (BSI; Derogatis, 1977) is a reliable and valid self-report inventory that consists of 53 items where the individual is asked to rate the extent to which they have been bothered by various domains of psychological functioning within the past week. Responses range from 0 ("not at all") to 4 ("extremely") and they are scaled using the t-score distribution (Mean of 50, Standard Deviation [SD] of 10). The BSI consists of nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. For the current analysis, the Positive Symptom Distress Index score was used to represent overall psychological symptomology/distress over the past week.

Parenting Stress Index (PSI). The Parenting Stress Index (PSI-4; Abidin, 1983) is a reliable and valid measure used to determine the extent of stress within the parent-child dynamic. The PSI-4-SF (short form), utilized in this study, consists of an abbreviated 36-item inventory divided into three domains: Parental Distress (PD), Parent-Child Dysfunctional Interaction (P-CDI), and Difficult Child (DC). Responses are scaled using a t-score distribution. The Parental Distress Score was used to reflect parental perception of their own parenting distress over the past week.

Caregiver Acculturation Ratings. Caregiver acculturation status was explored as an indicator of potential stress, as less identification with mainstream culture, coupled with high identification with heritage culture has been theorized to be a potential stressor (e.g., Berry, 1980). Prior to the appointment, caregivers were asked "On a scale from 0 to 10, where 0 is 'Not at All' and 10 is 'Completely', how much do you feel your way of life reflects your heritage culture?". As added context, the following description of heritage culture was provided to participants, "It may be the culture of your birth, the culture in which you have been raised, or

another culture that forms part of your background. Pick the culture that has influenced you most. If you do not feel that you have been influenced by any other culture, please try to identify the culture that may have had the most impact on previous generations of your family". Caregivers were then asked, "On a scale from 0 to 10, where 0 is 'Not at All' and 10 is 'Completely', how much do you feel your way of life reflects mainstream North American/Canadian culture?". Higher scores reflect greater identification with mainstream or heritage culture.

When possible, caregivers' self-reported heritage culture was coded into the ethnic and cultural categories defined by Statistics Canada (2021), including North American, European, Caribbean, Latin/Central/South American, African, Asian, Oceanian, and Middle Eastern. Not all responses fit into ethnic and cultural categories based on geographic origin. Non-geographic based self-reported ethnic and cultural responses were listed together (e.g., Jewish, Christian, Muslim). Measuring acculturation allows researchers to better understand the extent to which mainstream North American culture and caregivers' own heritage culture are reflected in caregivers' daily lives. It was adapted (see Pillai Riddell et al., 2018) from the Vancouver Index of Acculturation (Ryder et al., 2000) and Berry's (1992) bi-dimensional model of acculturation.

Statistical Analysis Plan

Bivariate correlations between the predictor variables and caregiver pain ratings were examined. Three linear regression models examined each of the clusters of predictors separately (FLACC, NFCS, and caregiver psychological/emotional functioning variables; child sex was used as a covariate) to parsimoniously build a final model that integrated both toddler pain behaviour and parent psychological variables. A final hierarchical linear regression model was estimated to examine the relative contribution of child and caregiver factors to the prediction of

caregiver pain ratings. The fourth and final model included only the significant predictors from the first three models. Child sex was included as a covariate in the first three models because previous research has shown that infant sex predicts parental pain ratings (Moon et al., 2008; Pillai Riddell et al., 2014). However, child sex was not included in the final model as it was not a significant predictor of pain ratings in this sample.

This study experienced missing data across the different variables and this was examined qualitatively. Missing data most often randomly occurred for the child facial coding data due to equipment failure at the clinics. At most, missing NFCS data per time point (pre-needle, post-needles 1,2 and 3) reached 51 (out of 156) missing values (post-needle 2), though the other time points experienced less data loss. In terms of post-visit phone calls, 28 parents were unreachable for the BSI and 22 were missing for the PSI. All other variables experienced less than 10% of data loss. Missing data were handled using pairwise deletion for each analysis. All assumptions for multiple linear regression were tested and met. IBM SPSS Statistics Software (Version 28) was used for all analyses. Power analyses indicated an adequate sample size to achieve 80% power for a medium effect at a significance criterion of $\alpha = .05$. Data available on request.

Results

Means and standard deviations of all variables are included in Tables 2-4, as well as intercorrelations among predictor variables of interest and the outcome (caregiver pain ratings).

Predicting Caregiver Pain Ratings: Models 1-3

Supplementary tables 1-3 present the details of the first three linear regression models predicting caregiver pain ratings from FLACC scores, NFCS scores, and caregiver psychological variables separately. Based on these penultimate models, NFCS Reactivity, FLACC Reactivity,

FLACC Minute 1, FLACC Minute 2, Pre-needle worry, and Post-needle worry were tested in the final model.

Final Model: Predicting Caregiver Pain Ratings with All Significant Predictors

Table 5 presents the details of the final linear regression model predicting caregiver pain ratings using the significant predictors from the first three models. The results of the regression revealed that the model was significant $F(6,107) = 5.95$, $p < .001$, accounting for 20.8% of the variance in caregiver pain ratings. Caregiver psychological variables, namely pre- and post-needle worry, were the only predictors that remained significant ($\beta = .23$, $p < .05$ and $\beta = .21$, $p < .05$ respectively), with more pre- and post-worry indicating higher pain ratings. Steps 1 and 2 in the final model also significantly predicted pain ratings (accounting for 8% and 9% of the variance in pain ratings), with greater behavioural child pain generally predicting a higher caregiver pain rating (with the exception of FLACC minute 1). However, none of these variables independently contributed to the outcome as did pre- and post-needle worry which emerged as unique predictors in the final step.

Discussion

The goal of this study was to examine the relative contributions of child and caregiver factors in predicting caregiver pain ratings during child immunizations over the second year of life. Given the steep developmental trajectory in early childhood, this paper importantly examines predictors of pain ratings in an understudied developmental period (toddlerhood). Further, this research builds on previous studies that outline the significance of infant pain-related distress behaviour on pain ratings (Pillai Riddell et al., 2014) while also expanding on influential caregiver factors previously shown to affect pain ratings in preschool children (Mamedova et al., 2019).

Given that previous research shows that parent ratings of their child's pain do not highly correlate with children's pain scores (Kelly et al., 2002) and that parents tend to underestimate their child's pain (Kamper et al., 2016; St-Laurent-Gagnon et al., 1999), it is essential to outline the factors that influence caregiver pain ratings to ensure appropriate pain management techniques are utilized. The current study found that the final model accounted for 20.8% of the variance in pain ratings. The only predictors that remained significant were caregiver worry prior to and following the needle. In other words, when actual child pain-related distress behaviour (both fine-grained facial action units and more gross body movements) were put in the model, caregiver worry variables accounted for unique variance in pain ratings, while child behaviours dropped out of the model as non-significant predictors. As mentioned earlier, the dyadic feedback loop through which caregivers influence child pain responding is emphasized by the Development of Infant Acute Pain Responding- Revised Model (DIAPR-R; Pillai Riddell et al., 2022). As such, the findings of this study lend support to the DIAPR-R 2022 model, which outlines how caregivers' own internal factors significantly influences their interpretation of the pain, beyond the child's actual pain behaviour. This study adds further credence to a significant concern in pediatric medicine that children's pain care is predicated on proxy ratings that have been shown in numerous studies to under- or overestimate child reports, or not be significantly related to the child's pain-related distress behaviour. It is particularly important for young children who are not yet capable of self-report.

This research underscores the importance of paying attention to the caregiver context and managing caregivers' anxieties and worries during painful medical procedures. Even beyond influencing pain judgements and pain care, studies show that parental anxiety significantly predicts child pain and anxiety during medical events (Anthony et al., 2011; Jacobsen et al.,

1990), with one study specifically reporting that parent anxiety prior to pediatric immunizations significantly correlated with measures of infant distress during the immunization (Bernard & Cohen, 2006). Another study found that the relationship between parent preprocedural anxiety and child pain was mediated by children's procedural anxiety, such that the preprocedural anxiety of the parent inadvertently influenced procedural anxiety within the child which, in turn, increased the child's pain (Bearden et al., 2012). The current study's measure of worry asked about the caregivers' worry in relation to the needle, which may encompass several concerns surrounding the immunization. For example, parents may be worried about the child's reaction to the needle, both emotionally and physically (i.e., side effects). They may also harbour negative beliefs about vaccines or concerns surrounding the administration of the needle. Thus, all these worries surrounding their child's vaccination may accumulate and ultimately impact their responses before, during, and after the immunization. Therefore, it is essential that caregivers are able to manage their own stress in order to prevent adding any additional stress to the child. It should also be noted that in this sample, levels of worry and pain ratings were generally low during these visits. This may be due to the toddlers' age, as both children and caregivers would have had previous experiences with immunizations during infancy. Consequently, this research should be reproduced in more stressful environments such as hospital settings.

Although our final model did not find a significant relationship between broader emotional functioning (i.e., outside the immediate immunization appointment) and caregiver pain ratings, in the steps leading up to the final model, an interesting exploratory bivariate relationship was elucidated. The relationship with the mainstream acculturation variable was seen in the predicted direction (i.e., the more an individual reported they identified with mainstream culture, the lower the pain scores). It is well-known in the literature that different

ethnic or cultural groups employ different parenting styles (Kotchick & Forehand, 2002) and thus may enact different behavioural responses to child pain. For example, one study found that caregivers who self-identified highly with individualist heritage cultures tended to show greater emotional availability, which in turn predicted lower pain scores for infants (O'Neill et al., 2016). Considering this effect on parental behaviour, cultural identification or level of acculturation may also impact caregiver pain ratings. For example, in this sample, higher identification with mainstream culture may indicate less stress associated with acculturation allowing for an effective behavioural response to the child and in turn, a lower pain rating. Ultimately, a reduction in stress in any manner, related to acculturation or any other factor that may increase parent stress during a distressing child event such as vaccination, may allow caregivers to respond more appropriately to their child's pain.

From the DIAPR-R 2022 model perspective, the dyadic feedback loops between parent responses to child pain strongly emphasize the interconnections between the parent and the child in the context of child pain. Therefore, since parent mental health has been found to influence parent responsiveness to child pain (i.e., parents with depressive symptoms engage in more protective and catastrophizing responses to child pain; Fussner et al., 2018), it seems reasonable to suggest that their ability to appropriately recognize the level of their child's pain would also be impacted by emotional functioning. Future research should continue to explore the impact of stress and other mental health factors that may impact caregivers' ability to interpret and respond to their children's pain. Another area for future research is the potential role that parental locus of control over their child's pain may play in their worry about their child's pain, their pain ratings, and the pain-soothing behaviours they enact. Additionally, more research is needed to specifically analyze the effect of caregiver pain schemas on the particular pain management

strategies that they choose to enact, such as topical anesthetics, distraction, and comfort (Chou et al., 2012; Pillai Riddell et al., 2023; Trottier et al., 2019). Research shows that these strategies are effective in reducing pain in children. According to the DIAPR-R 2022 model, the caregiver's pain management techniques depend on their assessment of the child's pain; greater interpretation of pain may lead to an increase in soothing behaviours and lower assessment of pain may lead to less soothing behaviours, which may in turn impact the child's pain behaviours. Therefore, assessment of pain schemas and pain management strategies can reciprocally influence one another and should further be analyzed concurrently. The current study does not focus on specific pain management strategies nor does it touch upon the physiological consequences for caregivers during child pain and thus cannot make any conclusions regarding these important aspects of the DIAPR-R 2022 model. Finally, further to the use of our measure of acculturation, while based on a strong theoretical framework, more work must be done to validate a measure of acculturative stress that can be feasibly used in primary care settings.

In terms of limitations, several caveats must be discussed. The generalizability of the study results may be affected by the caregivers' high education level, English proficiency (which would reduce acculturation variability in our sample), as well as our inclusion of only healthy full-term toddlers. This may limit generalizing to individuals of lower education status and children who have experienced greater pain in early infancy such as children who were born premature, have had previous stays in the NICU and have chronic conditions or developmental delays. Moreover, our team did not report race and ethnicity data but chose to ask participants to report the heritage culture(s) that have influenced their way of life most and then how much both their self-reported heritage culture and mainstream North American/Canadian culture influenced their daily lives. This was done to get a sense of acculturative stress. The construct of

acculturative stress was based on Berry's classic bi-dimensional model (Berry, 1992), and while a more restrictive construct, was considered more appropriate for our research focus. As explained earlier, acculturative stress serves as a hypothesized direct mechanism of *how* culture would impact pain judgments. From our perspective, race and ethnicity are context-bound terms that often vary in operationalization by both research participants and researchers. Moreover, how race and ethnicity would link to pain judgements is more complex and indirect. However, it is recognized that this makes it more difficult to generalize to studies that use race and ethnicity to describe their participants and more work must be done due to evolving flaws in the bi-dimensional model that do not account for the complexity of acculturation today (e.g., multiple-stop migration/refugee journeys; routine access to other cultural influences from increased travel and easy access to international movies, television/streaming shows, and music).

This study has important clinical implications that should be noted. Given how caregivers' interpretation of their child's pain may impact their ability to respond to their child's pain, it is essential that any factors that impact their pain assessments be addressed and managed. As such, based on the study results, medical professionals are encouraged to be attentive to caregivers who may present signs of worry and should attempt to alleviate their worry by answering any questions they have, building their confidence with pain management techniques, or addressing specific concerns they may have about the pain or the vaccination itself. In addition, it may be helpful to inform caregivers about what to expect during their child's painful procedure to ensure they are better prepared and can regulate their own emotional state, particularly for new parents who may not know what to expect. Specifically, educating caregivers on expectations surrounding a painful experience at key developmental periods of a child's life may reduce internal stress and allow them to focus more on external indicators (i.e.,

child's behaviour) when assessing their child's level of pain. Medical professionals working with young children, particularly those incapable of self-report, may want to consider care for young children as a dyadic context. By focusing on the parent (e.g., alleviating worry) they will likely be able to improve medical care for the young child.

In conclusion, this study highlights the importance of considering the various factors that may be influencing caregivers' ratings of their child's pain at different developmental stages. It is especially important to analyze these factors with younger children (infants and toddlers) who are unable to verbally communicate their pain and whose parents' pain ratings hold even more weight. Given the potentially lasting effects of inadequate pain management, it is essential to accurately assess and react to child pain, especially in the context of child vaccinations which are common routine appointments for young children. This study found that beyond the contribution of child pain-related distress behaviours, caregiver worry plays a significant role in determining caregivers' ratings of their child's pain. In fact, worry (pre and post) contributed more to pain ratings than peak distress pain behaviours of the child. These findings lend support to the DIAPR-R 2022 model by highlighting the influence of caregiver factors on their appraisal of their child's pain and adding results from a new developmental period to the existing literature. Future research should build on these findings by examining additional variables that may influence caregiver ratings of child pain as well as understanding these relationships at other key developmental stages.

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References

Abidin, R. R. (1983). *The Parenting Stress Index*. Pediatric Psychology Press.

Akbarzadeh, G., Daniali, H., Javdzadh, M., Caes, L., Ranjbar, S., & Habibi, M. (2018). The relationship of parental pain catastrophizing with parents reports of children's anxiety, depression, and headache severity. *Iranian Journal of Child Neurology*, *12*(1), 55–66.

Anand, K.S., Grunau, R. E., & Oberlander, T.F. (1997). Developmental character and long-term consequences of pain in infants and children. *Pain Management in Children, 6*(4), 703-724. https://doi.org/10.1016/S1056-4993(18)30274-8.

Anthony, K. K., Bromberg, M. H., Gil, K. M., & Schanberg, L. E. (2011). Parental perceptions of child vulnerability and parent stress as predictors of pain and adjustment in children with chronic arthritis. *Children's Health Care, 40*(1), 53-69. DOI: 10.1080/02739615.2011.537938

Bearden, D. J., Feinstein, A., & Cohen, L. L. (2012). The influence of parent preprocedural anxiety on child procedural pain: Mediation by child procedural anxiety. *Journal of Pediatric Psychology*, *37*(6), 680–686, https://doi.org/10.1093/jpepsy/jss041

Bernard, R., & Cohen, L. (2006). Parent anxiety and infant pain during pediatric immunizations. *Journal of Clinical Psychology in Medical Settings,13*(3), 285–290. https://doi.org/10.1007/s10880-006-9027-6

Berry, J.W. (1980). Acculturation as varieties of adaptation. In: A.M. Padilla (Eds.), *Acculturation: Theory, models, and some new findings* (pp. 9-25). Boulder, CO: Westview.

Berry, J. W. (1992). Acculturation and adaptation in a new society. *International migration*, *30*, 69-69.

Brudvik, C., Mouette, S-V., Baste, V., & Morken, T. (2017). A comparison of pain assessment by physician's, parent's, and children in an outpatient setting. *Emergency Medicine Journal, 34*(3), 138-144. https://doi.org/10.1136/emermed-2016-205825

Chou, Y. C., Yip, W. H., Chang, L. Y., & Lin, C. H. (2012). Reducing neonatal vaccination pain: The effectiveness of behavioral interventions. *Journal of Nursing & Healthcare Research*, *8*(1).

Conger, K. J., Rueter, M. A., & Conger, R. D. (2000). The role of economic pressure in the lives of parents and their adolescents: The family stress model. In L. Crockett & R. Silbereisen (Eds.), Negotiating adolescence in times of social change (pp. 201–233). Cambridge University Press

Derogatis, L. R. (1975). *Brief Symptom Inventory*. Baltimore, MD: Clinical Psychometric Research.

Fitzgerald, M. (2005). The development of nociceptive circuits. *Nature Reviews Neuroscience, 6*, 507–520. https://doi.org/10.1038/nrn1701

Fussner, L. M., Schild, C., Holley, A. L., & Wilson, A. C. (2018). Parent chronic pain and mental health symptoms impact responses to children's pain. *Canadian Journal of Pain*, *2*(1), 258–265. https://doi.org/10.1080/24740527.2018.1518119

Gennis, H., Pillai Riddell, R., O'Neil, M., Katz, J., Taddio,. A., Garfield, H., & Greenberg, S. (2018). Parental psychological distress moderates the impact of a video intervention to help parents manage young child vaccination pain, *Journal of Pediatric Psychology*, 43 (10)1170–1178, https://doi.org/10.1093/jpepsy/jsy058

Grunau, R., & Craig, K. D. (1987). Pain expression in neonates: Facial action and cry. *Pain*, *28*(3), 395–410. https://doi.org/10.1016/0304-3959(87)90073-X

Grunau, R. E., Whitfield, M. F., Petrie-Thomas, J., Synnes, A. R., Cepeda, I. L., Keidar, A., Rogers, M., Mackay, M., Hubber-Richard, P., & Johannesen, D. (2009). Neonatal pain, parenting stress and interaction, in relation to cognitive and motor development at 8 and 18 months in preterm infants. *Pain*, *143*(1-2), 138–146. https://doi.org/10.1016/j.pain.2009.02.014

Guinsburg, R., de Araújo Peres, C., Branco de Almeida, M. F., de Cássia Xavier Balda, R., Cássia Berenguel, R., Tonelotto, J., & Kopelman, B. I. (2000). Differences in pain expression between male and female newborn infants. *Pain*, *85*(1-2), 127–133. https://doi.org/10.1016/s0304-3959(99)00258-4

Jacobsen, P. B., Manne, S. L., Gorfinkle, K., & Schorr, O. (1990). Analysis of child and parent behavior during painful medical procedures. *Health Psychology, 9*, 559–576.

Kamper, S. J., Dissing, K. B., & Hestbaek, L. (2016). Whose pain is it anyway? Comparability of pain reports from children and their parents. *Chiropractic & Manual Therapies*, *24*, 24. https://doi.org/10.1186/s12998-016-0104-0

Kelly, A. M., Powell, C. V., & Williams, A. (2002). Parent visual analogue scale ratings of children's pain do not reliably reflect pain reported by child. *Pediatric Emergency Care*, *18*(3), 159–162. https://doi.org/10.1097/00006565-200206000-00002

Kotchick, B.A., & Forehand, R. (2002). Putting parenting in perspective: A discussion of the contextual factors that shape parenting practices. *Journal of Child and Family Studies, 11*, 255–269. https://doi.org/10.1023/A:1016863921662

Lilley, C. M., Craig, K. D., & Grunau, R. E. (1997). The expression of pain in infants and toddlers: developmental changes in facial action. *Pain*, *72*(1-2), 161–170. https://doi.org/10.1016/s0304-3959(97)00034-1

Mamedova, K., Pillai Riddell, R. R., DiLorenzo, M. G., Flora, D. B., Garfield, H., & Greenberg, S. (2019). Parental report of self and child worry during acute pain: A critical factor in determining parental pain judgment. *The Clinical Journal of Pain*, *35*(8), 696–702. https://doi.org/10.1097/AJP.0000000000000731

Merkel, S., Voepel-Lewis, T., & Malviya, S. (2002). Pain assessment in infants and young children: The FLACC scale. *American Journal of Nursing, 102*(10), 55–8. 10.1097/00000446-200210000-00024

Miller, M., & Csizmadia, A. (2022). Applying the family stress model to parental acculturative stress and Latinx youth adjustment: A review of the literature. *Journal of Family Theory & Review*, *14*(2), 275–293. https://doi.org/10.1111/jftr.12448

Moon, E. C., Chambers, C. T., Larochette, A. C., Hayton, K., Craig, K. D., & McGrath, P. J. (2008). Sex differences in parent and child pain ratings during an experimental child pain task. *Pain Research & Management*, *13*(3), 225–230. https://doi.org/10.1155/2008/457861

O'Neill, M. C., Pillai Riddell, R., Garfield, H., & Greenberg, S. (2016). Does caregiver behavior mediate the relationship between cultural individualism and infant pain at 12 months of age? *The Journal of Pain*, *17*(12), 1273–1280. https://doi.org/10.1016/j.jpain.2016.08.008

Perreira, K. M., Marchante, A. N., Schwartz, S. J., Isasi, C. R., Carnethon, M. R., Corliss, H. L., Kaplan, R. C., Santisteban, D. A., Vidot, D. C., van Horn, L., & Delamater, A. M. (2019). Stress and resilience: Key correlates of mental health and substance use in the Hispanic community health study of Latino youth. *Journal of Immigrant and Minority Health, 21*(1), 4–13. https://doi.org/10.1007/s10903-018-0724-7

Peters, J. W., Koot, H. M., Grunau, R. E., de Boer, J., van Druenen, M. J., Tibboel, D., & Duivenvoorden, H. J. (2003). Neonatal Facial Coding System for assessing postoperative pain in infants: Item reduction is valid and feasible. *The Clinical Journal of Pain*, *19*(6), 353–363. https://doi.org/10.1097/00002508-200311000-00003

Pillai Riddell, R., Bucsea, O., Shiff, I., Chow, C., Gennis, H.G., Badovinac, S., DiLorenzo-Klas, M., Racine, N.M., Ahola Kohut, S., Lisi, D., Turcotte, K., Stevens, B., & Uman, L.S. (2023). Non-pharmacological management of infant and young child procedural pain. *Cochrane Database of Systematic Reviews, 6*. Art. No.: CD006275. DOI: 10.1002/14651858.CD006275.pub4.

Pillai Riddell, R., Flora, D.B., Stevens, S.A., Greenberg, S., & Garfield, H. (2014). The role of infant pain behaviour in predicting parent pain ratings. *Pain Research and Management*, *19*(5): e124-32. doi:/10.1155/2014/934831

Pillai Riddell, R., Jasim, S., & Hamwi, L. (2022). Out of the mouth of babes: A lot about pain has nothing to do with pain. *Pain, 163*, S117-S125. https://doi: 10.1097/j.pain.0000000000002761

Pillai Riddell, R., O'Neill, M. C., Campbell, L., Taddio, A., Greenberg, S., & Garfield, H. (2018). Featured article: The ABCDs of pain management: A double-blind randomized controlled trial examining the impact of a brief educational video on infants' and toddlers' pain scores and parent soothing behavior. *Journal of Pediatric Psychology*, *43*(3), 224–233. https://doi.org/10.1093/jpepsy/jsx122

Pillai Riddell, R., Racine, N. (2009). Assessing pain in infancy: The caregiver context. *Journal of Pain Research and Management*,*14*, 27-32. doi:10.1155/201/410725

Pillai Riddell, R. R., Stevens, B. J., Cohen, L. L., Flora, D. B., & Greenberg, S. (2007). Predicting maternal and behavioral measures of infant pain: The relative contribution of maternal factors. *Pain*, *133*(1-3), 138–149. https://doi.org/10.1016/j.pain.2007.03.020

Ryder, A. G., Alden, L. E., & Paulhus, D. L. (2000). Is acculturation unidimensional or bidimensional? A head-to-head comparison in the prediction of personality, self-identity, and adjustment. *Journal of Personality and Social Psychology*, *79*(1), 49–65. https://doi.org/10.1037//0022-3514.79.1.49

Statistics Canada (2021). *List of ethnic or cultural origins 2021*. https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1310929

St-Laurent-Gagnon, T., Bernard-Bonnin, A. C., & Villeneuve, E. (1999). Pain evaluation in preschool children and by their parents. *Acta Paediatrica (Oslo, Norway : 1992)*, *88*(4), 422–427. https://doi.org/10.1080/08035259950169819

Trottier, E. D., Doré-Bergeron, M. J., Chauvin-Kimoff, L., Baerg, K., & Ali, S. (2019). Managing pain and distress in children undergoing brief diagnostic and therapeutic procedures. *Paediatrics & Child Health*, *24*(8), 509–535. https://doi.org/10.1093/pch/pxz026

Vinall, J., & Grunau, R. (2014). Impact of repeated procedural pain-related stress in infants born very preterm. *Pediatric Research, 75*, 584–587. https://doi.org/10.1038/pr.2014.16

Figure 1:
The Development of Infant Acute Pain Responding- Revised 2022 (DIAPR-R 2022).

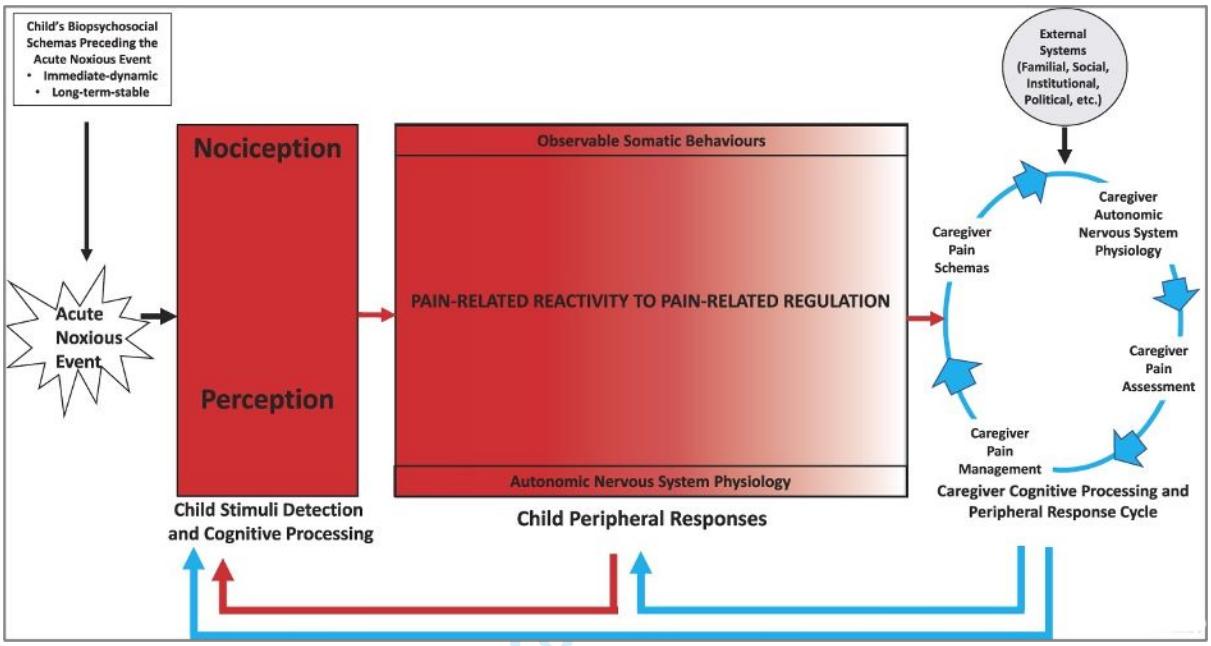

Table 1: Demographic Information

Demographics	**n=156**
Relationship to Infant	
Mother	133 (85.3%)
Father	20 (12.8%)
Other	1 (0.6%)
Missing	2 (1.3%)
Child Age	
18 months	95 (60.8%)
24 months	61 (39.1%)
Child Sex	
Male	89 (57.1%)
Female	66 (42.3%)
Missing	1 (0.6%)
Parent Education Level	
Graduate School/Professional Training	75 (48.1%)
University Graduate (4 years college)	47 (30.1%)
Partial University (at least 1 year)	3 (1.9%)
Trade School/Community College	22 (14.1%)
High School Graduate	1 (0.6%)
Missing	8 (5.1%)
Reported Heritage Culture	
North American	36 (23.1%)
European	47 (30.1%)
Caribbean	1 (0.6%)
Latin, Central and South American	5 (3.2%)
African	3 (1.9%)
Asian	33 (21.2%)
Oceanian	2 (1.3%)
Middle Eastern	8 (5.1%)
Non-Geographic based Cultures Reported • Jewish • Catholic • Mennonite • Arabic • Islamic	12 (7.7%)
Mixed	3 (1.9%)
Missing	6 (3.8%)

Table 2: Descriptive Information of FLACC Variables and Correlations

Variable	*M*	*SD*	Range	1	2	3	4
1. Pre-needle Distress (FLACC baseline)	9.32	9.93	0-40				
2. Pain-related Distress (FLACC reactivity)	21.73	9.57	0-40	.48**			
3. Pain-related Distress (FLACC minute 1)	13.37	10.84	0-40	.46**	.60**		
4. Pain-related Distress (FLACC minute 2)	11.17	11.22	0-40	.42**	.42**	.72**	
5. Parent Pain Ratings	4.15	2.45	0-10	.17*	.28**	.11	.20*

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 3: Descriptive Information of NFCS Variables and Correlations

Variable	*M*	*SD*	Range	1	2	3	4
1. Pre-needle Distress (NFCS baseline)	26.31	21.53	0-70				
2. Pain-related Distress (NFCS reactivity)	48.99	18.72	0-70	.47**			
3. Pain-related Distress (NFCS minute 1)	27.04	17.99	0-70	.30**	.39**		
4. Pain-related Distress (NFCS minute 2)	24.83	17.18	0-70	.23*	.16	.50**	
5. Parent Pain Ratings	4.15	2.45	0-10	.12	.29**	.14	.07

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4: Descriptive Information of Caregiver Psychological Variables and Correlations

Variable	*M*	*SD*	1	2	3	4	5	6
1. Positive Symptom Distress Index (Brief Symptom Inventory; T-scores)	51.48	6.02						
2. Parental Distress (Parental Stress Index; T-scores)	32.84	12.85	.18*					
3. Pre-needle Worry	2.17	2.41	.05	.03				
4. Post-needle Worry	1.43	2.00	-.06	.01	.41**			
5. Parent Heritage Rating	6.35	2.68	-.05	.17	-.05	.12		
6. Parent Mainstream Rating	7.87	2.01	-.17	.11	-.04	-.13	.06	
7. Parent Pain Rating	4.15	2.45	.05	-.05	.32**	.37**	.03	-.17*

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 5: Predicting Caregiver Pain Ratings- Combined Final Model

Predictor Variables	*B*	*SE B*	β	Adjusted R^2	R^2 Change
Step 1				.08**	--
Pain-related Distress (NFCS Reactivity)	.02	.02	.12		
Step 2				.09**	.01
Pain-related Distress (FLACC reactivity)	.05	.04	.20		
Pain-related Distress (FLACC minute 1)	-.02	.03	-.11		
Pain-related Distress (FLACC minute 2)	.02	.03	.10		
Step 3				.21***	.12***
Pre-needle Worry	.23	.10	.23*		
Post-needle Worry	.26	.12	.21*		

*p < .05, **p < .01, ***p < .001

Supplementary Table 1: Predicting Caregiver Pain Ratings from Child Pain Behaviour (FLACC)

Predictor Variables	*B*	*SE B*	β	Adjusted R^2	R^2
Model 1				.14***	.17***
Child Sex	-.09	.38	-.02		
Pre-needle Distress (FLACC baseline)	.03	.02	.10		
Pain-related Distress (FLACC reactivity)	.09	.03	.33***		
Pain-related Distress (FLACC minute 1)	-.06	.03	-.26*		
Pain-related Distress (FLACC minute 2)	.06	.02	.27*		

*p < .05, **p < .01, ***p < .001

Supplementary Table 2: Predicting Caregiver Pain Ratings from Child Pain Behaviour (NFCS)

Predictor Variables	*B*	*SE B*	β	Adjusted R^2	R^2
Model 2				.03	.09
Child Sex	-.07	.54	-.02		
Pre-needle Distress (NFCS baseline)	-.003	.01	-.02		
Pain-related Distress (NFCS reactivity)	.04	.02	.29*		
Pain-related Distress (NFCS minute 1)	.004	.02	.03		
Pain-related Distress (NFCS minute 2)	.002	.02	.01		

*p < .05, **p < .01, ***p < .001

Supplementary Table 3: Predicting Caregiver Pain Ratings from Parental Psychological Variables

Predictor Variables	*B*	*SE B*	β	Adjusted R^2	R^2
Model 3				.14***	.19***
Child Sex	.08	.43	.02		
Pre-needle Worry	.22	.10	.22*		
Post-needle Worry	.33	.12	.27**		
Mainstream Culture Rating	-.14	.11	-.11		
Heritage Culture Rating	.03	.08	.03		
Positive Symptom Distress Index	.01	.04	.03		
Parental Distress Score	-.02	.02	-.09		

*p < .05, **p < .01, ***p < .001