Check for updates

Received: 29 September 2020 | Accepted: 14 October 2021

DOI: 10.1002/ejp.1878

EJP European Journal of Pain

ORIGINAL ARTICLE

Psychological distress in early childhood and the risk of adolescent spinal pain with impact

Amabile Borges Dario[1] | **Steven James Kamper**[1,2,3] | **Christopher Williams**[3,4] | **Leon Straker**[5] | **Peter O'Sullivan**[5] | **Robert Schütze**[5] | **Anne Smith**[5]

[1]Sydney School of Health Science, University of Sydney, Sydney, Australia

[2]Nepean Blue Mountains Local Health District, Penrith, Australia

[3]School of Medicine and Public Health, Hunter Medical Research Institute, University of Newcastle, Callaghan, Australia

[4]Centre for Pain, Health and Lifestyle, New Lambton Heights, Australia

[5]School of Physiotherapy and Exercise Science, Curtin University, Perth, Australia

Correspondence
Dr Amabile Borges Dario, Room 228, F Block, 75 East Street, Lidcombe, NSW, 2141, Australia.
Email: amabile.dario@sydney.edu.au

Funding information
The University of Western Australia (UWA); Raine Medical Research Foundation; Telethon Kids Institute; Women and Infants Research Foundation; Curtin University; Murdoch University; The University of Notre Dame Australia; Edith Cowan University; National and Medical Research Council (NHMRC), Grant/Award Number: 353514 and 323200

Abstract

Background: Spinal pain (SP), including neck and back pain, is common and often associated with poor mental health and reduced quality of life of adolescents. Contemporary understanding of SP favours a biopsychosocial approach, and emerging evidence suggests the stronger influence of psychological rather than other factors.

Objectives: We aimed to investigate if experiencing psychological distress in early childhood increases the risk of spinal pain with impact during adolescence.

Methods: 1175 adolescents from a prospective cohort study (Raine Study Gen2) were included. Psychological distress was assessed at ages 2, 5, 8 and 10 using Child Behaviour Check List (CBCL). CBCL total and subscale scores (internalizing and externalizing symptoms) were converted to age-standardized scores and dichotomized according to t-scores (>60=high distress). Life-time spinal pain, including low back, mid back, or neck/shoulder, was measured at age 17. We were interested in adolescent SP with impact (care seeking, medication use, school absenteeism, daily activity interference, leisure activity interference) and defined cases as SP with impact (one or more) or greater impact (two or more) impacts. We investigated the longitudinal associations between childhood psychological distress and adolescent SP using univariate and multivariable logistic regression models.

Results: Psychological distress in childhood increased the odds of adolescent SP with impact by 33% (OR 1.33; 95% CI 1.01–1.76), but not spinal pain with greater impact (OR 1.22; 95% 0.83–1.80). Internalizing symptoms were associated with SP with greater impact and externalizing symptoms with SP with impact after adjusting for a range of potential child and family confounders.

Conclusion: Psychological distress in childhood increases the risk of SP with impact in adolescence and may be a promising prevention target.

Significance: Our findings provide evidence that psychological distress early in life is an independent risk factor for spinal pain with impact during adolescence. As psychological distress during childhood is potentially modifiable, it may be a promising target for research on the prevention of consequential spinal pain in adolescence. Identifying and addressing psychological distress in children may be an important component of best practice to reduce consequential spinal pain in adolescents.

 © 2021 European Pain Federation - EFIC ®

1 | INTRODUCTION

For nearly 3 decades, spinal pain, including neck and back pain, has been a leading cause of years lived with disability globally (James et al., 2018). The prevalence of spinal pain rises quickly during adolescence and by late adolescence is similar to adults (Kamper et al., 2016). Adolescent spinal pain is often associated with functional interference (e.g. school absenteeism), poor mental health and reduced quality of life (Kamper et al., 2016, 2018; O'Sullivan et al., 2012; Rees et al., 2011). Unfortunately, spinal pain and its consequences will often have a negative impact on children and adolescents' development and lifestyle and continue into adulthood (Coenen et al., 2017; Kamper et al., 2016). Given the substantial individual and societal burden, spinal pain in adolescents represents an important public health issue that requires attention (O'Sullivan et al., 2012). However, little is known about the factors that increase the risk of spinal pain in adolescents (Kamper et al., 2016), especially pain with negative impacts such as interference with daily and leisure activity, care-seeking, medication use and school absenteeism.

Spinal pain is characterized by a range of factors that are commonly conceptualized within a biopsychosocial framework (Kamper et al., 2016). A range of biological (e.g. posture) and social (e.g. socioeconomic status) factors are potential risk factors for adolescent spinal pain (Huguet et al., 2016; Kamper et al., 2016). There is also growing interest in the importance of psychological factors, such as distress, in the development and persistence of paediatric pain (O'Sullivan et al., 2019). A recent systematic review in children and adolescents suggests that psychosocial factors (e.g. depressed mood/depressed symptoms, mental distress and emotional disfunction) are most consistently associated with spinal pain, more than others suggested risk factors (e.g. body mass index) (Huguet et al., 2016). Psychological distress during childhood may be a key driver of adolescent spinal pain with impact.

Psychological distress can be broadly defined as an aversive emotional state characterized by a perceived inability to cope in the context of various stressors such as emotional, behavioural and social problems (Ridner, 2004). Left untreated, childhood psychological distress can lead to many adverse health outcomes (Danese et al., 2007; Winning et al., 2016). Previous research shows that early life distress is associated with biological dysregulation, including metabolic and inflammatory dysfunction and poor health outcomes in adulthood (e.g. cardiovascular diseases) (Danese et al., 2007; Winning et al., 2016). Elevated distress in childhood is also likely to reflect behavioural issues (e.g. sub-optimal coping skills), particularly emotion regulation, which is a likely risk factor for the development of chronic pain (Koechlin et al., 2018). The lack of evidence investigating a potential role of early childhood psychological distress as a risk factor for adolescent spinal pain is an important gap in knowledge. The present study used data from an Australian cohort study to investigate if the experience of psychological distress in early childhood increases the risk of adolescent spinal pain with impact. We investigate five pain-related negative impacts that often interfere in adolescents life and well-being such as limitations with daily and leisure activity, school absenteeism, care seeking and medication use. A further aim was to explore whether the risk of spinal pain with impact was dependent on the type of psychological distress, as characterized by internalizing (e.g. anxiety and depression) and externalizing problems (e.g. aggression and attention deficit hyperactivity disorders).

2 | METHODS

2.1 | Study design

Prospective cohort study of adolescents enrolled in the Raine Study (www.rainestudy.org.au). The Raine Study cohort was established to investigate the contributions of early family and environmental factors on health outcomes throughout life.

2.2 | Sample

Participants of the Raine Study Generation 2 (Gen2 2, 3, 5, 8, 10-year follow-ups), born between 1989 and 1992, were included. Raine Study participants are representative of the general population in Western Australia (Straker et al., 2017). Outcome data were collected by research assistants blinded to the risk factors. Comprehensive details of recruitment procedures, measures, data collection and further information on the representativeness of the Raine sample are provided elsewhere (Straker et al., 2017). We obtained ethics approval for this study from the Curtin University Human Research Ethics Committee and the Princess Margaret Hospital Human Research Ethics Committee (HR84/2005). Consent was gained from the participants' guardians.

2.3 | Exposure

Psychological distress was assessed at ages 2, 5, 8 and 10 using the Child Behaviour Check List (CBCL). The CBCL is a valid instrument with good sensitivity (83%) and specificity (67%) to assess psychological distress and has good test–retest reliability in the Raine cohort (Zubrick

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

et al., 1997). Using the CBCL, carers reported information regarding their child's behavioural and emotional status including somatic complaints, symptoms of anxiety and depression, withdrawal, aggressive behaviour, rule-breaking behaviour, social problems, thought problems and attention problems (Achenbach & Ruffle, 2000). The CBCL administration is tailored to the age of children. For children aged two (CBCL/2–3), parents complete a 99-item instrument (Achenbach et al., 1987). For older children (from 4 to 10 years), a 118-item CBCL instrument is used (TM, 1991). CBCL total raw scores and two broad-band scales—internalizing (problems of anxiety/depression, withdrawal and somatic complaints scales) and externalizing (rule-breaking and aggressive behaviour)—were converted to age-standardized scores (*t*-scores having a mean = 50 and *SD* = 10). Higher scores indicate more psychological distress, including internalizing symptoms and externalizing behavioural issues. Given that *t*-scores below 60 are considered low risk (Achenbach, 1991; Robinson et al., 2011) we operationalized psychological distress as scores of 60 and above that includes borderline and clinical scores. Children were classified as being exposed to psychological distress if they experienced psychological distress in one or multiple timepoints.

2.4 | Outcomes

When participants were approximately 17 years old, information about spinal pain, including the lower back, thoracic and neck areas, was collected using a paper-based questionnaire. Adolescents' life-time experience of spinal pain was self-reported and assessed using standard 'yes and no' questions based on the Nordic Musculoskeletal Questionnaire (Crawford, 2007). Participants were asked, 'Have you ever had low back (or mid back, or neck/shoulder) pain'? Participants who answered 'yes' to any of these questions were categorized as having spinal pain. Participants answering 'yes' to any spinal pain question were also asked five additional questions (Table S1) related to spinal pain-related impact: 1. care-seeking; 2. medication use; 3. school absenteeism; 4. daily activity interference; 5. leisure activity interference (e.g. sport). Participants with no pain or pain with no impact were categorized as 'no spinal pain'. As we were interested in pain with impact, the cases for this study were defined as those with spinal pain and one or more of the impacts listed above (e.g. back pain that resulted in medication use). To estimate whether findings are sensitive to our definition of the outcome, we performed a sensitivity analysis to investigate adolescent spinal pain with greater impact with adolescents reporting two or more spinal pain-related impacts (e.g. back pain that resulted in medication use and school absence).

2.5 | Co-variates

Confounding and moderator factors were selected prior to the analysis considering the biopsychosocial models of paediatric pain (Pillai Riddell et al., 2013). For this study, we defined a theoretical model linking spinal pain and psychological distress using available co-variates in the Raine Study Generation 2 and included potential confounders related to the child (e.g. engaged in sports out of school, general health, body mass index) and the family environment (e.g. family income, maternal education, primary carer history of back pain) (Table S2). Evidence suggests that psychosocial distress and spinal pain are more frequently reported in girls than boys (Kamper et al., 2016; Rees et al., 2011). Adolescent girls also tend to report MSK with more impact pain than adolescent boys (O'Sullivan et al., 2012). Thus, child sex was tested as a moderator.

2.6 | Statistical analysis

Participants were included in the study if they answered questions for spinal pain outcomes at follow-up (17 years) and the CBCL at three or more time points (2, 5, 8, 10 years of age) (Figure 1). We included children with three or more valid time-points for CBCL to avoid classifying a child as not exposed to psychological distress in case data were missing. Descriptive characteristics of the sample at baseline included anthropometric data, lifestyle factors, psychological distress and family characteristics. We investigated the longitudinal associations between psychological distress and adolescent spinal pain with impact using univariate and multivariable logistic regression models. In Figure 2, we present a theoretical causal model that could explicate the relationships among the variables that affect adolescent spinal pain with impact. All potential confounders were included in the final multivariable models. An interaction term between sex and CBCL was tested to evaluate sex as a moderator of the association between psychological distress and spinal pain. Child sex was tested as a moderator due to the potential to affect the strength of the relation between psychological distress and back pain, based on evidence that psychosocial distress and back pain are more frequent and severe in girls than boys (Perquin et al., 2000; Watson et al., 2002).

In addition to the complete case analysis, we performed a sensitivity analysis to investigate whether findings are sensitive to data incompleteness using multiple imputation and improve the validity of our results. In addition

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

to the complete case analysis, we performed a sensitivity analysis to investigate whether findings are sensitive to data incompleteness using multiple imputation. Multiple imputation has the potential to assist identification of bias due to missing data and improve the validity results. We replaced missing data prior to estimating logistic regression models. Sequential chained equations using all variables from Table S2 were used to create ten imputed datasets. To impute missing psychological distress data, CBCL *t*-scores were imputed and categorical indicator variables then derived from the imputed *t*-scores for each dataset. Subsequent logistic regression models were estimated using the imputed data, with coefficients and standard errors adjusted for the variability between imputation sets using Rubin's combination rules. The level of significance was set at $p < 0.05$ for the estimates of association in the regression models, and estimates are presented as odds ratios (OR) and 95% confidence intervals (CI). Descriptive analyses were performed using version 14.0 of Stata/IC statistical software (StataCorp LP). Regression models and multiple imputation (mi suite of commands) were performed using version 15.0 of Stata/IC.

3 | RESULTS

3.1 | Sample characteristics and prevalence estimates

Table 1 displays the characteristics of 1175 adolescents divided into; no spinal pain, spinal pain with impact (≥1 impact), spinal pain with greater impact (≥2 impacts). The mean age of participants was 17.0 years (*SD* 0.3) and females represented 53% of the sample. The proportions of adolescents in our sample with adolescent spinal pain with impact and greater impact were 49.4% and 14.1% respectively.

4 | PSYCHOLOGICAL DISTRESS AND RISK OF DEVELOPING SPINAL PAIN WITH IMPACT

We performed preliminary analysis to investigate whether sex moderated the association between distress and spinal pain with impact. No evidence for interaction was detected (*p*-value >0.10, see Table S3 for sex-specific results), so sex was not included as a moderator in any adjusted models. Adjusted estimates include all confounders in Figure 1. In adjusted analysis, children reporting higher CBCL total scores had 33% higher odds of developing spinal pain with impact in adolescence (OR 1.33, 95% CI 1.01–1.76). Higher internalizing behaviour scores did not achieve statistical

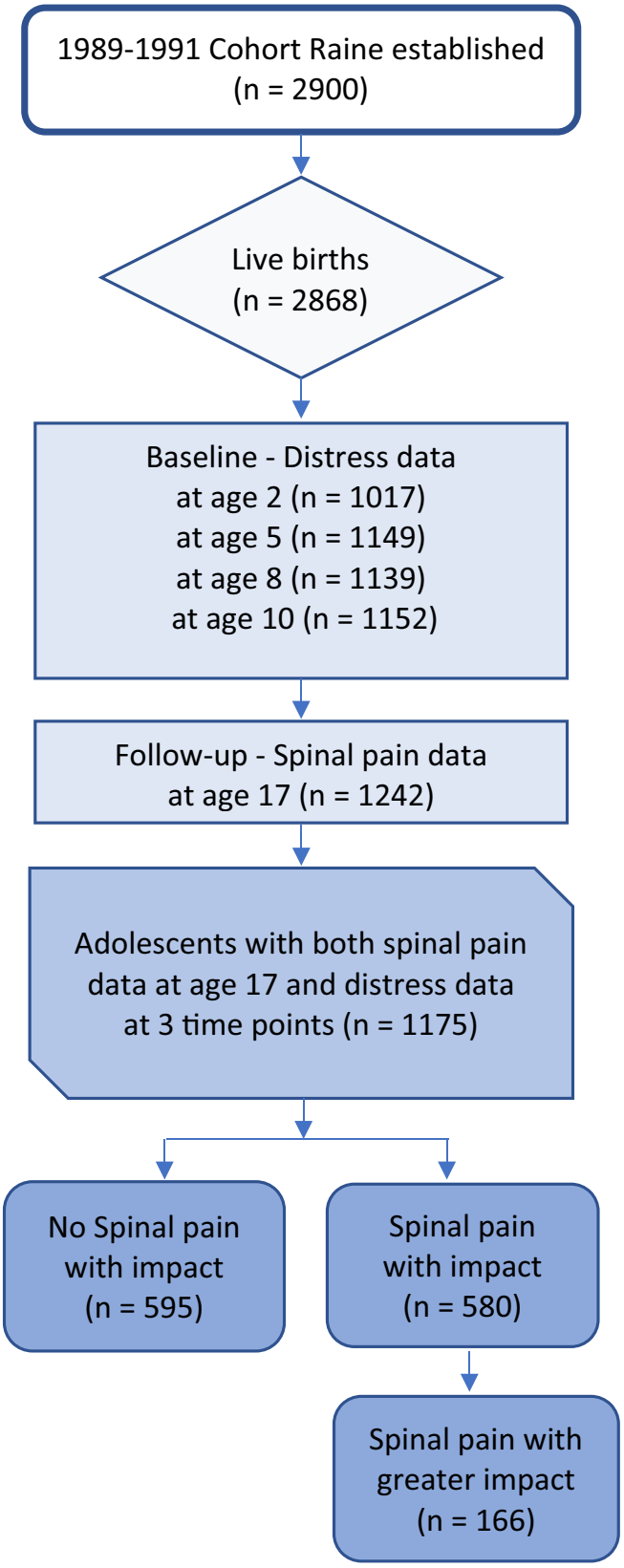

FIGURE 1 Flowchart of sample selection

significance (OR 1.27; 95% CI 0.97–1.67) while higher externalizing behaviour scores increased the odds of spinal pain with impact by 49% (OR 1.49, 95% CI 1.13–1.97). The

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

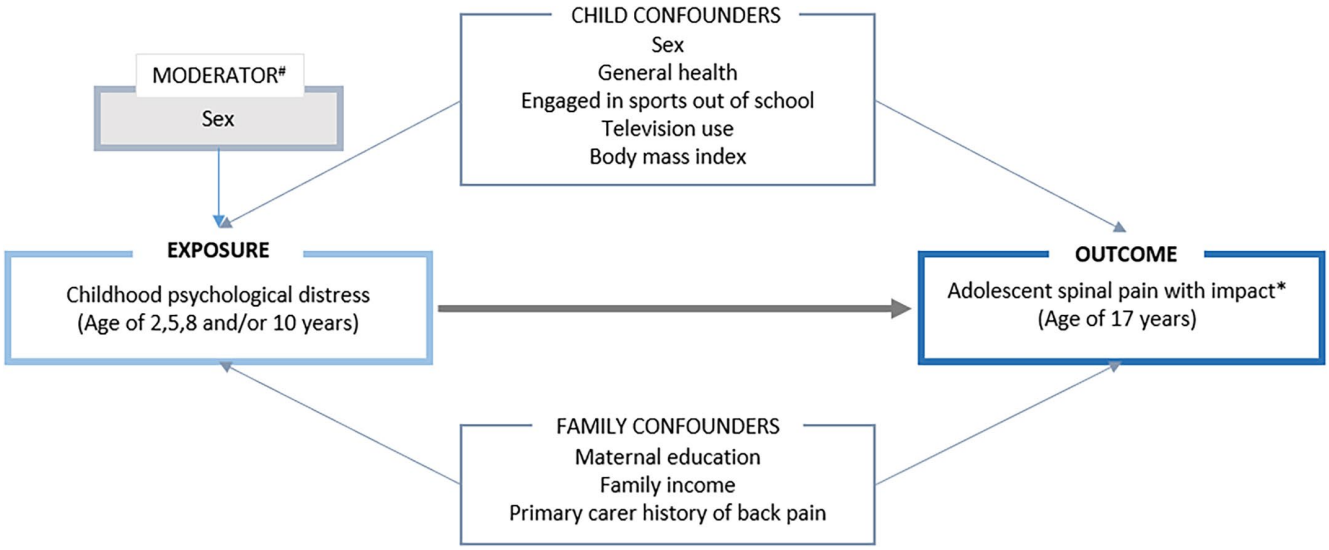

FIGURE 2 Theoretical causal model between childhood physiological distress and adolescent spinal pain, including confounding and moderator factors, inlcuded in this study. * One or more impact including: 1. care-seeking; 2. medication use; 3. school absenteeism; 4. daily activity interference; 5. leisure activity interference; # Tested

sensitivity analysis using imputed data showed comparable but often stronger associations (Table 2). We present estimates from unadjusted models for adolescent spinal pain with impact from the complete case and multiple imputed datasets in Table S4.

5 | PSYCHOLOGICAL DISTRESS AND RISK OF DEVELOPING SPINAL PAIN WITH GREATER IMPACT

In adjusted analysis, children reporting higher levels of CBCL total scores were not more likely to develop adolescent spinal pain with greater impact (OR 1.22, 95% CI 0.83–1.80). Higher internalizing behaviour scores increased the odds of spinal pain with impact by 49% (OR 1.49, 95% CI 1.02–2.17) while higher externalizing behaviour scores did not achieve statistical significance (OR 1.25; 95% CI 0.84–1.84). In the sensitivity analysis using imputed data, the models showed comparable but often stronger associations (Table 2). We present estimates from unadjusted models for adolescent spinal pain with greater impact from the complete case and multiple imputed datasets in Table S4.

6 | DISCUSSION

The purpose of this study was to investigate whether psychological distress in childhood increases the risk of developing life-time spinal pain with impact by late adolescence. Using prospective data over a 15-year period, our results suggest that children who experience psychological distress in childhood have 33% increased odds of developing spinal pain with impact at 17 years of age. Higher levels of both internalizing and externalizing symptoms issues in childhood were associated with greater odds of adolescent spinal pain with impact after adjusting for a range of potential confounders. However, these associations were not always consistent across spinal pain with impact and greater impact. Although sex differences are often identified in the prevalence of psychological distress and spinal pain, sex was not a moderator in our study. Our findings suggest that psychological distress in early childhood may act as an independent risk factor for spinal pain associated with impact in adolescence.

Our findings are consistent with the body of evidence indicating that cognitive and emotional psychological factors increase the risk of the development of pain (Huguet et al., 2016; O'Sullivan et al., 2019; Smith et al., 2017). Andreucci et al. (2021) reported similar findings suggesting that externalizing symptoms in early adolescence (age of 13), and to some extent internalizing symptoms, increases the odds of having musculoskeletal pain at the age of 17. Psychological distress has been associated with the transition from acute to chronic pain and the development of disabling pain conditions in children and adults (Hasenbring et al., 2001; Huguet et al., 2016; Meints & Edwards, 2018; Smith et al., 2017). The novel contribution of this paper is the temporal ordering of events, capturing early childhood distress and a critical period of time for the onset of spinal pain with impact in adolescents. We used a robust statistical analysis that aligns with

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 Study sample characteristics

Variables	Total ($n = 1175$)	No SP ($n = 595$)	SP with impact ($n = 580$)	SP greater impact ($n = 166$)
Children characteristics				
Sex (female), *n* (%)	618 (52.6)	281 (47.2)	337 (58.1)	102 (61.5)
BMI Trajectory[a1]	3 (2–5)	3 (2–5)	3 (2–5)	3 (2–5)
Engaged in sports out of school, *n* (%)	767 (66.8)	398 (68.3)	369 (65.3)	103 (64.4)
Television use[a2]	3 (2–4)	3 (2–4)	3 (2–4)	3 (2–4)
General Health[a3]	3 (3–3)	3 (3–3)	3 (3–3)	3 (2–3)
Psychological distress by age[a4], *n* (%)				
2 Years	111 (10.9)	46 (8.9)	65 (13.0)	22 (14.8)
5 Years	222 (19.3)	93 (16.0)	129 (22.8)	38 (23.5)
8 Years	195 (17.1)	81 (14.0)	114 (20.3)	38 (23.6)
10 Years	157 (13.6)	58 (9.9)	99 (17.5)	31 (19.4)
At anytime	368 (31.3)	157 (26.4)	211 (36.4)	66 (39.8)
Family characteristics				
High maternal education level, *n* (%)[a5]	264 (23.2)	144 (25.1)	120 (21.3)	38 (23.6)
Family income[a6]	7 (3–9)	7 (4–9)	6 (3–9)	6 (3–9)
Primary carer history of back pain, *n* (%)	826 (71.7)	404 (66.2)	422 (77.9)	126 (82.4)

Abbreviations: BMI: body mass index; *n*: number of participants; *SD*: standard deviation; SP, spinal pain including at least low back, thoracic and neck pain.
[a]Median and interquartile range; [1]Categorized as 1. very low, 2. low, 3. average, 4. ascending, 5. moderate-high and 6. high; [2]Categorized as 1. not at all, 2. up to 7 h/week, 3. 7 to 14 h/week, 4. 14 to 21 h/week, or 5. 21 h or more / week; [3]Categorized as 1. poor, 2. is ill as often as is well, 3. mostly well, 4. excellent; [4]Psychological distress was dichotomized based on Child Behaviour Check List age-standardized scores (T scores): no <60; yes >= 60; [5]Bachelors degree, Postgraduate diploma or higher degree; [6]Data from 10 years (if not available, we used data from 8 years). Classified into 10 ascendant categories as 1; <$8,000, 2; $8,001 - $16,000, 3; $16,001 - $25,000, 4; $25,001 - $30,000, 5; 30,001 - $35,000, 6; 35,001 -$40,000, 7; 40,001 - $50,000, 8; 50,001 - $60,000, 9; 60,001 - $70,000, 10; > $70,001 (Australian dollars).

contemporary methods to reduce risk of bias and improve validity of results. We adjusted our analysis for covariates from multiple child and family domains and tested sex as a moderator. We included five spinal pain impacts of importance to adolescents' lives.

Participant attrition may have masked stronger associations. To address this limitation, we performed multiple imputation analyses, which did not show major differences from the analysis of complete cases (Table S2). As our sample is from one geographic region in Australia, generalizability of the results may be another limitation. Although we found associations for both internalizing and externalizing symptoms, the relationships did not have a consistent pattern across spinal pain with impact and greater impact. For example externalizing behaviour issues were associated with spinal pain with impact, while internalizing issues were associated with spinal pain with greater impact (i.e. two or more pain-related impacts). The reason for the inconsistent results remains unknown but potentially due to imprecision of the estimates because of the smaller numbers of participants that experienced greater impact. This is a question worthy off further investigation. Another limitation is an absence of a measure of spinal pain with impact in early childhood, to account for previous history of pain. Thus, the issue of reverse causation (spinal pain leading to distress) is possible, even if unlikely given typically low prevalence of pain in this age group (Taimela et al., 1997). Also, our study did not consider other early-life pain experiences (e.g. abdominal pain) and childhood adversity that have been associated with central sensitization and development of pain later in life (Joergensen et al., 2019; You & Meagher, 2016). Finally, as with any observational study, we acknowledge the possibility of residual confounding and future trials need to confirm the causal effect of psychological distress.

Our findings are a valuable addition to the literature identifying the likelihood of psychological distress being a modifiable risk factor for spinal pain with impact in adolescents. Further work that investigates whether distress is modifiable may be a promising direction for research on prevention. It is reasonable to postulate that the knowledge from future studies on underlying mechanisms may contribute to prevention programs by identifying targets for interventions. For example the effects of stress-related factors on pain might be mediated through physiological and behavioural pathways. Elevated psychological distress

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Adjusted odds of developing adolescent spinal pain with impact at the age of 17 years due to psychological distress in childhood

	SP with impact		SP greater impact	
Psychological Distress[1]	**OR (95% CI)**	***n***	**OR (95% CI)**	***n***
CBCL Total Score[a]				
Complete cases	**1.33 (1.01 to 1.76)**	1045	1.22 (0.83 to 1.80)	1045
Multiple imputation[2]	**1.48 (1.13 to 1.92)**	1175	1.39 (0.97 to 2.00)	1175
CBCL subscales				
Internalizing[a]				
Complete cases	1.27 (0.97 to 1.67)	1045	**1.49 (1.02 to 2.17)**	1045
Multiple imputation[2]	**1.36 (1.05 to 1.76)**	1175	**1.55 (1.09 to 2.20)**	1175
Externalizing[a]				
Complete cases	**1.49 (1.13 to 1.97)**	1045	1.25 (0.84 to 1.84)	1045
Multiple imputation[2]	**1.58 (1.21 to 2.07)**	1175	1.39 (0.97 to 2.00)	1175

Abbreviations: BP: spinal pain including at least low back, thoracic and neck pain; CBCL: Child Behaviour Checklist; n: number of participants; OR: Odds ratio.

[a]Distress at either 2, 5, 8 and 10 years of age; [1] Confounders included in the models were child sex, engaged in sports out of school, general health, body mass index and family factors including family income, maternal education and primary carer history of back pain; Significant results in bold ($p \leq 0.05$); [2]multiple imputation of missing data (10 datasets).

in children is also likely to reflect underdeveloped emotion regulation skills (Koechlin et al., 2018). Although internalizing tendencies are more commonly associated with child functional somatic symptoms, externalizing problems often stem from difficulties with emotion regulation, including maladaptive coping with negative affect such as anger, sadness or anxiety (Compas et al., 2017; Halligan et al., 2013; Modecki et al., 2017). As maladaptive behavioural responses to distress and spinal pain are potentially modifiable (Pandey et al., 2018), they could be targets for preventive interventions.

Psychological distress is common in pre-adolescents, but the prevalence varies between studies (Cartwright-Hatton et al., 2006). In our sample, 3 out of 10 children had experienced high levels of distress by the age of 10 years. These results provide a rationale for targeting psychological distress in young people by explicitly teaching resilience, social and emotional learning skills broadly, for example in school curriculums. Resilience-focused approaches delivered in the school setting may show an advantage over individual interventions (Corrieri et al., 2014). Beyond positive effects in terms of improving mental health in childhood (Corrieri et al., 2014; Dray et al., 2017), these broad programs may be protective against consequential pain and chronic disease risk (Chida et al., 2008; Wirtz & von Kanel, 2017). Investments in children's mental health and wellbeing could bring benefits today and for decades to come due to the well-known individual and societal burden of spinal pain worldwide. However, future research is needed to understand causal mechanisms that drive the positive effects of resilience-focused interventions (Corrieri et al., 2014; Dray et al., 2017). A better understanding of the mechanism responsible for the positive results may help to strengthen these interventions.

Young children who report spinal pain and signs of distress (e.g. anxiety, depressed mood, aggressive behaviours) may also benefit from careful monitoring of psychological distress as psychologically informed care may reduce the risk of ongoing, consequential spinal pain (secondary prevention). This is consistent with the current evidence supporting the inclusion of psychological interventions as part of chronic pain management for reducing distress, pain intensity and disability in children and adolescents (Fisher et al., 2018). Similar to adults (Lin et al., 2019), identifying and addressing psychological distress (yellow flags) may be an integral part of best practice to reduce consequential spinal pain in children and adolescents.

In conclusion, the findings from this longitudinal study show that childhood psychological distress is an independent risk factor for the development of consequential spinal pain in adolescents. These results lend further support to the body of evidence suggesting that psychological distress is a promising direction for research on the prevention of adolescent spinal pain with impact.

ACKNOWLEDGEMENTS

We are grateful to the Raine Study participants and their families and we thank the Raine Study for cohort co-ordination and data collection. The core management of the Raine Study is funded by The University of Western Australia (UWA), Raine Medical Research Foundation; Telethon Kids Institute; Women and Infants Research Foundation;

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Curtin University; Murdoch University, The University of Notre Dame Australia and Edith Cowan University. The 17-year Raine Study follow-up was funded by the National and Medical Research Council (NHMRC) programme grant 353514 and NMHRC project grant 323200.

CONFLICT OF INTEREST

None.

AUTHORS' CONTRIBUTIONS

AD, AS, SK and RS designed the study with input from LS, CW, GK, POS. AD and AS ran the analysis. AD drafted the manuscript with input from AS, SK, RS, LS, CW, GK, POS and all authors discussed the results and commented on the manuscript.

ORCID

Amabile Borges Dario https://orcid.org/0000-0002-4818-7017
Steven James Kamper https://orcid.org/0000-0003-3012-5499
Leon Straker https://orcid.org/0000-0002-7786-4128
Peter O'Sullivan https://orcid.org/0000-0002-3982-4088
Anne Smith https://orcid.org/0000-0002-4667-7389

REFERENCES

Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist/4-18 and 1991 profile*. Burlington, VT: Department of Psychiatry, University of Vermont.

Achenbach, T. M., Edelbrock, C., & Howell, C. T. (1987). Empirically based assessment of the behavioral/emotional problems of 2- and 3- year-old children. *Journal of Abnormal Child Psychology*, *15*(4), 629–650. https://doi.org/10.1007/BF00917246

Achenbach, T. M., & Ruffle, T. M. (2000). The Child Behavior Checklist and related forms for assessing behavioral/emotional problems and competencies. *Pediatrics in Review*, *21*(8), 265–271. https://doi.org/10.1542/pir.21-8-265

Andreucci, A., Campbell, P., & Dunn, K. M. (2021). Are psychological symptoms a risk factor for musculoskeletal pain in adolescents? *European Journal of Pediatrics*, *180*, 2173–2183. https://doi.org/10.1007/s00431-021-04002-5

Cartwright-Hatton, S., McNicol, K., & Doubleday, E. (2006). Anxiety in a neglected population: Prevalence of anxiety disorders in pre-adolescent children. *Clinical Psychology Review*, *26*(7), 817–833. https://doi.org/10.1016/j.cpr.2005.12.002

Chida, Y., Hamer, M., Wardle, J., & Steptoe, A. (2008). Do stress-related psychosocial factors contribute to cancer incidence and survival? *Nature Clinical Practice Oncology*, *5*(8), 466–475. https://doi.org/10.1038/ncponc1134

Coenen, P., Smith, A., Paananen, M., O'Sullivan, P., Beales, D., & Straker, L. (2017). Trajectories of low back pain from adolescence to young adulthood. *Arthritis Care & Research*, *69*(3), 403–412. https://doi.org/10.1002/acr.22949

Compas, B. E., Jaser, S. S., Bettis, A. H., Watson, K. H., Gruhn, M. A., Dunbar, J. P., Williams, E., & Thigpen, J. C. (2017). Coping, emotion regulation and psychopathology in childhood and adolescence: A meta-analysis and narrative review. *Psychological Bulletin*, *143*(9), 939–991. https://doi.org/10.1037/bul0000110

Corrieri, S., Heider, D., Conrad, I., Blume, A., Konig, H. H., & Riedel-Heller, S. G. (2014). School-based prevention programs for depression and anxiety in adolescence: a systematic review. *Health Promotion International*, *29*(3), 427–441. https://doi.org/10.1093/heapro/dat001

Crawford, J. (2007). The Nordic Musculoskeletal Questionnaire. *Occupational Medicine*, *57*(4), 300–301. https://doi.org/10.1093/occmed/kqm036

Danese, A., Pariante, C. M., Caspi, A., Taylor, A., & Poulton, R. (2007). Childhood maltreatment predicts adult inflammation in a life-course study. *Proceedings of the National Academy of Sciences*, *104*(4), 1319–1324. https://doi.org/10.1073/pnas.0610362104

Dray, J., Bowman, J., Campbell, E., Freund, M., Wolfenden, L., Hodder, R. K., McElwaine, K., Tremain, D., Bartlem, K., Bailey, J., Small, T., Palazzi, K., Oldmeadow, C., & Wiggers, J. (2017). Systematic review of universal resilience-focused interventions targeting child and adolescent mental health in the school setting. *Journal of the American Academy of Child and Adolescent Psychiatry*, *56*(10), 813–824. https://doi.org/10.1016/j.jaac.2017.07.780

Fisher, E., Law, E., Dudeney, J., Palermo, T. M., Stewart, G., & Eccleston, C. (2018). Psychological therapies for the management of chronic and recurrent pain in children and adolescents. *Cochrane Database of Systematic Reviews*, *9*, 1–108. https://doi.org/10.1002/14651858.CD003968.pub5

Halligan, S. L., Cooper, P. J., Fearon, P., Wheeler, S. L., Crosby, M., & Murray, L. 2013. The longitudinal development of emotion regulation capacities in children at risk for externalizing disorders. *Development and Psychopathology*, *25*(2), 391–406. https://doi.org/10.1017/S0954579412001137

Hasenbring, M., Hallner, D., & Klasen, B. (2001). Psychological mechanisms in the transition from acute to chronic pain: over- or underrated? *Schmerz*, *15*(6), 442–447. https://doi.org/10.1007/s004820100030

Huguet, A., Tougas, M. E., Hayden, J., McGrath, P. J., Stinson, J. N., & Chambers, C. T. (2016). Systematic review with meta-analysis of childhood and adolescent risk and prognostic factors for musculoskeletal pain. *Pain*, *157*(12), 2640–2656. https://doi.org/10.1097/j.pain.0000000000000685

James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Accrombessi, M. M. K., … Murray, C. J. L. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, *392*(10159), 1789–1858. https://doi.org/10.1016/S0140-6736(18)32279-7

Joergensen, A. C., Lucas, R., Hestbaek, L., Andersen, P. K., & Nybo Andersen, A. M. (2019). Early-life programming of pain sensation? Spinal pain in pre-adolescents with pain experience in early life. *European Journal of Pediatrics*, *178*(12), 1903–1911. https://doi.org/10.1007/s00431-019-03475-9

Kamper, S. J., Michaleff, Z. A., Campbell, P., Dunn, K. M., Yamato, T. P., Hodder, R. K., Wiggers, J., & Williams, C. M. (2018). Back pain, mental health and substance use are associated in

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

adolescents. *Journal of Public Health*, *41*(3), 487–493. https://doi.org/10.1093/pubmed/fdy129

Kamper, S. J., Yamato, T. P., & Williams, C. M. (2016). The prevalence, risk factors, prognosis and treatment for back pain in children and adolescents: An overview of systematic reviews. *Best Practice & Research Clinical Rheumatology*, *30*(6), 1021–1036. https://doi.org/10.1016/j.berh.2017.04.003

Koechlin, H., Coakley, R., Schechter, N., Werner, C., & Kossowsky, J. (2018). The role of emotion regulation in chronic pain: A systematic literature review. *Journal of Psychosomatic Research*, *107*, 38–45. https://doi.org/10.1016/j.jpsychores.2018.02.002

Lin, I., Wiles, L., Waller, R., Goucke, R., Nagree, Y., Gibberd, M., Straker, L., Maher, C. G., & O'Sullivan, P. P. B. (2019). What does best practice care for musculoskeletal pain look like? Eleven Consistent Recommendations from high-quality Clinical Practice Guidelines: Systematic review. *British Journal of Sports Medicine*, *54*(2), 79–86. https://doi.org/10.1136/bjsports-2018-099878

Meints, S. M., & Edwards, R. R. (2018). Evaluating psychosocial contributions to chronic pain outcomes. *Progress in Neuropsychopharmacology & Biological Psychiatry*, *87*(Pt B), 168–182. https://doi.org/10.1016/j.pnpbp.2018.01.017

Modecki, K. L., Zimmer-Gembeck, M. J., & Guerra, N. (2017). Emotion regulation, coping, and decision making: Three linked skills for preventing externalizing problems in adolescence. *Child Development*, *88*(2), 417–426. https://doi.org/10.1111/cdev.12734.

O'Sullivan, K., O'Keeffe, M., Forster, B. B., Qamar, S. R., van der Westhuizen, A., & O'Sullivan, P. B. (2019). Managing low back pain in active adolescents. *Best Practice & Research Clinical Rheumatology*, *33*(1), 102–121. https://doi.org/10.1016/j.berh.2019.02.005

O'Sullivan, P. B., Beales, D. J., Smith, A. J., & Straker, L. M. (2012). Low back pain in 17 year olds has substantial impact and represents an important public health disorder: A cross-sectional study. *BMC Public Health*, *12*, 100. https://doi.org/10.1186/1471-2458-12-100

Pandey, A., Hale, D., Das, S., Goddings, A., Blakemore, S., & Viner, R. M. (2018). Effectiveness of universal self-regulation–based interventions in children and adolescents: A systematic review and meta-analysis. *JAMA Pediatrics*, *172*(6), 566–575. https://doi.org/10.1001/jamapediatrics.2018.0232

Perquin, C. W., Hunfeld, J. A., Hazebroek-Kampschreur, A. A., van Suijlekom-Smit, L. W., Passchier, J., Koes, B. W., & van der Wouden, J. C. (2003). The natural course of chronic benign pain in childhood and adolescence: A two-year population-based follow-up study. *Europan Journal of Pain*, *7*(6), 551–9. https://doi.org/10.1016/S1090-3801(03)00060-0. PMID: 14575668.

Pillai Riddell, R., Racine, N. M., Craig, K. D., & Campbell, L. (2013). *Psychological theories and biopsychosocial models in paediatric pain*. Oxford University Press.

Rees, C. S., Smith, A. J., O'Sullivan, P. B., Kendall, G. E., & Straker, L. M. (2011). Back and neck pain are related to mental health problems in adolescence. *BMC Public Health*, *11*, 382. https://doi.org/10.1186/1471-2458-11-382

Ridner, S. H. (2004). Psychological distress: concept analysis. *Journal of Advanced Nursing*, *45*(5), 536–545. https://doi.org/10.1046/j.1365-2648.2003.02938.x

Robinson, M., Mattes, E., Oddy, W. H., Pennell, C. E., van Eekelen, A., McLean, N. J., Jacoby, P., Li, J., De Klerk, N. H., Zubrick, S. R., Stanley, F. J., & Newnham, J. P. (2011, May). Prenatal stress and risk of behavioural morbidity from age 2 to 14 years: the influence of the number, type, and timing of stressful life events. *Development and Psychopathology*, *23*(2), 507–20. https://doi.org/10.1017/S0954579411000241

Smith, A., Beales, D., O'Sullivan, P., Bear, N., & Straker, L. (2017). Low back pain with impact at 17 years of age is predicted by early adolescent risk factors from multiple domains: Analysis of the Western Australian Pregnancy Cohort (Raine) Study. *Journal of Orthopaedic & Sports Physical Therapy*, *47*(10), 752–762. https://doi.org/10.2519/jospt.2017.7464

Straker, L., Mountain, J., Jacques, A., White, S., Smith, A., Landau, L., Stanley, F., Newnham, J., Pennell, C., & Eastwood, P. (2017). Cohort Profile: The Western Australian Pregnancy Cohort (Raine) Study-Generation 2. *International Journal of Epidemiology*, *46*(5), 1384–1385j. https://doi.org/10.1093/ije/dyw308

Taimela, S., Kujala, U. M., Salminen, J. J., & Viljanen, T. (1997). The Prevalence of low back pain among children and adolescents: A Nationwide, Cohort-Based Questionnaire Survey in Finland. *Spine*, *22*(10), 1132–1136. https://doi.org/10.1097/00007632-199705150-00013

Watson, K. D., Papageorgiou, A. C., Jones, G. T., Taylor, S., Symmons, D. P. M., Silman, A. J., & Macfarlane, G. J. (2002). Low back pain in schoolchildren: Occurrence and characteristics. *Pain*, *97*(1–2), 87–92. https://doi.org/10.1016/S0304-3959(02)00008-8

Winning, A., Glymour, M. M., McCormick, M. C., Gilsanz, P., & Kubzansky, L. D. (2016). Childhood psychological distress as a mediator in the relationship between early-life social disadvantage and adult cardiometabolic risk: Evidence from the 1958 British Birth Cohort. *Psychosomatic Medicine*, *78*(9), 1019–1030. https://doi.org/10.1097/psy.0000000000000409

Wirtz, P. H., & von Kanel, R. (2017). Psychological stress, inflammation, and coronary heart disease. *Current Cardiology Reports*, *19*(11), 1–10. https://doi.org/10.1007/s11886-017-0919-x

You, D. S., & Meagher, M. W. (2016). Childhood adversity and pain sensitization. *Psychosomatic Medicine*, *78*(9), 1084–1093. https://doi.org/10.1097/PSY.0000000000000399

Zubrick, S. R., Silburn, S. R., Gurrin, L., Teoh, H., Shepherd, C., Carlton, J., & Lawrence, D. (1997). *Western Australian Child Health Survey; Education, Health and Competence*. Perth: Australian Bureau of Statistics and the TVW Telethon Institute for Child Health Research. https://research-repository.uwa.edu.au/en/publications/western-australian-child-health-survey-education-health-and-compe

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Dario, A. B., Kamper, S. J., Williams, C., Straker, L., O'Sullivan, P., Schütze, R., & Smith, A. (2022). Psychological distress in early childhood and the risk of adolescent spinal pain with impact. *European Journal of Pain*, 26, 522–530. https://doi.org/10.1002/ejp.1878

15322149, 2022, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ejp.1878 by University Of Sydney, Wiley Online Library on [21/02/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License