THE PREVALENCE, TRAJECTORIES AND PREDICTORS OF RECURRENT PAIN AMONG ADOLESCENTS: A POPULATION-BASED APPROACH

by

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Abstract

Recurrent pains are a complex set of conditions that cause great discomfort and impairment to children, adolescents, and adults. The objectives of this study were to (a) determine the prevalence of headache, stomachache, and backache in a nationally representative adolescent sample and (b) evaluate a psychosocial model for the development of adolescent recurrent pain that included underlying vulnerability factors (i.e., gender, pubertal development and the presence of parent chronic pain), precipitating stimuli (i.e., illness, injury/hospitalization, and stressful life events), and psychological factors (i.e., anxiety/depression, and self-esteem). Statistics Canada’s National Longitudinal Survey of Children and Youth, a large longitudinal population-level database, was used to assess a cohort of 2,488 10- to 11-year-old adolescents five times, every 2 years. Results showed that, across 12-19 years of age, weekly rates ranged from 26.2-31.8% for headache, 13.5-22.2% for stomachache, and 17.6-25.8% for backache. Across 12-19 years, 3.6-8.6% adolescents experienced multiple types of weekly recurrent pain. Chi-square tests indicated that girls had higher rates of pain than boys for all types of pain, at all time points. Structural equation modeling using latent growth curves considered psychosocial factors predictive of stable trajectories (i.e., predictors of both start- and end-point intercepts), as well as increasing recurrent pain trajectories over time (i.e., predictors of slopes). Gender and anxiety/depression were predictive of the start- and end-point intercepts and/or slopes for all three types of pain. Some factors were predictive of only certain pain types, for example parent headache was predictive of stable, high frequencies of headache, while fewer injuries and lower pubertal development were predictive of increasing frequencies of stomachache. Some factors were only predictive of certain trajectories types, for example low self-esteem
was predictive of stable, high frequencies of recurrent pain, but not increasing frequencies of recurrent pain. Finally, many factors, such as parent chronic pain, illness/hospitalization, and stressful life events, were not found to be predictive in any analyses. The results of this study suggest that adolescent recurrent pain is very common and that psychosocial factors, such as gender and anxiety/depression, predict trajectories of recurrent pain across adolescence.
# Table of Contents

Abstract ........................................................................................................... ii

Table of Contents .......................................................................................... iv

List of Tables ................................................................................................. viii

List of Figures ............................................................................................... ix

Acknowledgements ....................................................................................... x

Introduction ................................................................................................... 1

  Recurrent Pain in Children ................................................................. 1

Prevalence of Recurrent Pain in Children .................................................. 2
  Canadian Studies ...................................................................................... 3
  International Studies ................................................................................. 4

Synthesizing Across Population-Level Studies ......................................... 4

Conceptual Models, Psychosocial Factors and Recurrent Pain ................... 7
  Existing Conceptual Models ...................................................................... 8
  Commonalities Across Existing Models .................................................. 11

Proposed Model for Psychosocial Factors Associated with the Development of Recurrent Pain ............................................................ 12

  Underlying Vulnerabilities ....................................................................... 12

  Precipitating Stimuli ................................................................................. 14

  Psychological Factors ............................................................................... 15

Key Elements in Future Research on Psychosocial Models for Adolescent Recurrent Pain Development ............................................................ 17

  Longitudinal Designs ............................................................................... 17
Multiple Types of Recurrent Pain ..............................................18
Predictor Strength .................................................................18
Summary .................................................................................19
Study Design ..........................................................................19
Purpose, Specific Aims and Hypotheses ..................................20
Method ....................................................................................22
Participants ............................................................................22
Sample Survey Weights .........................................................22
Cohort Description .................................................................24
Procedure ................................................................................26
Measures ................................................................................26
Demographic Variables ..........................................................27
Recurrent Pain .......................................................................28
Underlying Vulnerability Factors .............................................28
Precipitating Factors ...............................................................30
Psychological Factors .............................................................31
Data Analysis ..........................................................................33
Recurrent Pain Prevalence .......................................................33
Recurrent Pain Development Model ........................................35
Basic Descriptive Data Analyses .............................................35
Model Testing Analyses ...........................................................35
Results ....................................................................................40
Recurrent Pain Prevalence .......................................................40
List of Tables

Table 1  Summary of Recent Population-level Studies on the Prevalence of Pediatric Chronic Pain..............................82

Table 2  Cohort Size, Age in Years and Percent Female across the Five Survey Cycles..................................................83

Table 3  Summary of Measures in the Recurrent Pain Development Model........84

Table 4  Pair-wise Pearson Correlations among Psychological Predictors........85

Table 5  Relationships between headache, stomachache and backache trajectories...87

Table 6  Psychosocial Factors and Headache Slope.................................................88

Table 7  Psychosocial Factors and Stomachache Slope............................................89

Table 8  Psychosocial Factors and Backache Slope...............................................90
List of Figures

Figure 1  Psychosocial Model for the Development of Adolescent Recurrent Pain
(Headache, Stomachache or Backache) ......................................................... 91

Figure 2  Headache Frequency in the Past 6 Months .......................................... 92

Figure 3  Stomachache Frequency in the Past 6 Months ...................................... 93

Figure 4  Backache Frequency in the Past 6 Months ........................................... 94

Figure 5  Prevalence of Multiple Weekly or More Frequent Pains .......................... 95

Figure 6  Prevalence of Weekly or More Headache by Gender ............................. 96

Figure 7  Prevalence of Weekly or More Stomachache by Gender ......................... 97

Figure 8  Prevalence of Weekly or More Backache by Gender ............................. 98

Figure 9  Psychosocial Model for the Development of Adolescent Recurrent Pain
(Headache, Stomachache or Backache) Based on the Results of the Present
Study ............................................................................................................. 99

Figure 10 Issues to be Addressed in Future Research on the Psychosocial Model for the
Development of Adolescent Recurrent pain (Headache, Stomachache,
Backache) ...................................................................................................... 100
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Introduction

Recurrent Pain in Children

The children, adolescents, and adults who live with recurrent pain experience significant discomfort and impairment. Recurrent pains are a type of chronic pain where pain is experienced in intense episodes multiple times a week or month. Chronic pain is defined by the International Association for the Study of Pain as pain that persists beyond normal healing time, as quantified through medical experience (Merskey & Bogduk, 1994), and may involve single or multiple areas of the body (American Pain Society [APS], 2001). The term *chronic* captures both pain that persists in an ongoing nature, as well as pain that has a recurrent or episodic pattern (i.e., recurrent pain; APS, 2001). Chronic pain may occur as a result of acute pain or may arise from no known physical injury (APS, 2001). Regardless of cause, chronic pain can be difficult to diagnose, as patients will not always show outward signs of injury, such as wounds.

Chronic pain is associated with varying levels of disability, which do not necessarily correspond with the initial amount of physical damage or level of pain experience (APS, 2001). Over 50% of children with chronic pain take pain medication and over 30% see medical professionals for treatment during the course of a three-month period (Perquin, Hazebroek-Kampschreur, Hunfeld, van Suijlekom-Smit et al., 2000; Perquin et al., 2001). Aside from health care utilization, chronic pain in children is associated with difficulties in academic achievement, emotional well-being, as well as peer and family relationships (Hunfeld et al., 2002; Palermo, 2000). Furthermore, chronic pain is likely to persist over time. Walker and colleagues (1995) found that adolescents with recurrent abdominal pain continued to have high levels of pain and disability as young adults. Research by Hestbaek,
Leboeuf-Yde and Kyvik (2006) supported these findings indicating the persistence of recurrent pain from adolescence to early adulthood in a study using a very large longitudinal Danish twin database. Their study showed that young people aged 12 to 22 years who experienced low back pain in the past year were more likely than young people who had not experienced low back pain in the past year to have low back pain 8 years later (odds ratio = 3.5; Hestbaek et al., 2006). The results of these studies indicate that the negative impact of pain does not appear to be contained to childhood or adolescence.

Prevalence of Recurrent Pain in Children

In a review of the literature at the time, Goodman and McGrath (1991) stated that methodological issues common to many of the studies considered in their review made pediatric pain prevalence estimates difficult to generate. Goodman and McGrath (1991) noted that previous research investigating the prevalence of pediatric pain often employed samples that were small in size and not necessarily representative of the general population. Also, many studies considered a narrow age range (Goodman & McGrath, 1991). Further, it was difficult to determine the prevalence of pain in pediatric populations because research studies differed on how to define often specific types of pain (Goodman & McGrath, 1991). The authors concluded their review by stating that, due to the design flaws in previous research, the epidemiology of pediatric pain was essentially unknown and was waiting to be determined by future research with improved and consistent methods.

Recent research has taken these recommendations seriously and attempted to determine the prevalence of pediatric pain using population-based methods and a more consistent definition of what level of frequency identifies recurrent pain. Population-based methods involve testing samples that are representative of the population in terms of specific
characteristics, such as age, ethnic, and/or regional population demographics. Presently, pain is often considered to be recurrent if it occurs multiple times a week or month (Egger, Costello, Erkanli & Angold, 1999; El-Metwally, Salminen, Auvinen, Kautiainen, & Mikkelsson, 2006; Ghandour, Overpeck, Huang, Kogan & Scheidt, 2004; Gordon, Dooley & Wood, 2004; Hakala, Rimpela, Salminen, Virtanen, & Rimpela, 2002; Larsson & Sund, 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Perquin, Hazebroek-Kampschreur, Hunfeld, van Suijlekom-Smit et al.,2000). Canadian studies are reviewed in the text below, followed by a summary of recent large-scale examinations of pain prevalence conducted around the world (see Table 1 for a summary of recent international studies on pain prevalence). This section ends with a discussion of what can be drawn from the body of literature on pediatric pain prevalence.

**Canadian studies.** Very little population-based research has documented the prevalence of recurrent pain in Canadian children. However, recently researchers have begun to utilize large Canadian health surveys as a tool to study recurrent pain in children and adolescents. Mustard, Kalcevich, Frank and Boyle (2005) used the Ontario Child Health Study (Statistics Canada, 1999) to study individuals who were sampled at ages 4 to 16 years, and then again as adults, 18 years later. Mustard and colleagues (2005) found that the lifetime prevalence of backache in the young adult sample was 53.2%, the 1-year point-prevalence rate was 35.2% and the annual incidence rate for experiencing a first-time backache episode was 7.5%.

Recently, Gordon and colleagues (2004) used the National Longitudinal Survey of Children and Youth (NLSCY; Statistics Canada, 1997) to study the prevalence and correlates of headache in Canadian adolescents. The NLSCY is a longitudinal health survey of children
performed by Statistics Canada. Gordon and colleagues (2004) used a cross-sectional approach to study a cohort of 2,090 12- and 13-year-olds. Twenty seven percent of adolescents reported having headaches at least once a week. The results of this study show that headaches are common in Canadian early-adolescents. The authors successfully replicated these findings by considering two other cohorts of adolescents, this time sampling from a different cycle of data collection in the NLSCY database (Dooley, Gordon & Wood, 2005). In these new samples, 26.3% of 12- and 13-year-olds and 31.1% of 14- and 15-year-olds reported having headaches at least once a week (Dooley et al., 2005).

*International studies.* As well as these Canadian studies, research attempting to determine the prevalence of pediatric chronic pain has been conducted in countries around the world (see Table 1). In these international studies, headache, stomachache and backache were the most researched types of recurrent pain. Groholt and colleagues (2003) found these three types of pain to be the most commonly experienced during childhood. Rates of recurrent pain vary across pediatric chronic pain prevalence studies. For example, Perquin and colleagues (2000) found that 25% of children experienced some type of recurrent pain, while Ghandour and colleagues (2004) found that 29.1% of girls experienced headaches. Rates for the prevalence of headaches in girls and boys together ranged between 8.1% (Larsson & Sund, 2005) and 14.9% (Groholt et al., 2003). Stomachache/recurrent abdominal pain (RAP) prevalence rates in girls and boys ranged from 2.8% (Egger et al., 1999) to 10.2% (Boey, Yap, & Goh, 2000).

*Synthesizing across population-level studies.* Methodological issues may underlie the differences in pain prevalence rates found across population-level studies. Although all previous studies had a large sample size, many considered children from a narrow age range
Dooley et al., 2005; El-Metwally et al., 2006; Gordon et al., 2004; Larsson & Sund, 2005; Ramchandani, Hotopf, Sandhu, & Stein, 2005) or from only from one city or region in the country (Egger, Angold, & Costello, 1998; Egger et al., 1999; El-Metwally et al., 2006; Larsson & Sund, 2005; Mustard et al., 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Ramchandani et al., 2005). The study by Ghandour and colleagues (2004) only considered girls. Other studies only considered the prevalence of one type of recurrent pain (Boey et al., 2000; Dooley et al., 2005; El-Metwally et al., 2006; Gordon et al., 2004; Larsson & Sund, 2005; Mustard et al., 2005). Further, many used school-based data collection methods (Boey et al., 2000; El-Metwally et al., 2006; Larsson & Sund, 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000) or cross-sectional designs (Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Gordon et al., 2004; Perquin et al., 2000). Some studies used unique means of classifying recurrent pain. For example, the study by Groholt and colleagues (2003) considered recurrent pain to be present if the child indicated pain that occurred at least every other week or if pain was noted to be mild, moderate or severe. Some studies required children to report that pain interfered with normal daily activity (Boey et al., 2000), while most others did not. In combination, these methodological issues limit the generalizability of each study’s findings and also make their prevalence findings difficult to compare to one another.

Nonetheless, some common themes arise in studies investigating recurrent pain prevalence. First, studies often show that prevalence rates are higher in older school-age children compared to younger children (Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Ramchandani et al., 2005) and/or older adolescents compared to younger adolescents and pre-teens (Egger et al., 1998; Hakala et al., 2002; Perquin, Hazebroek-
In a study of recurrent pain in children aged 7-17 years from Nordic countries, Groholt and colleagues (2003) found that headache and backache were more prevalent in older children, however this pattern did not hold for stomachache. However, Ghandour and colleagues' (2004) study of American girls found that prevalence for monthly stomachaches increased at each grade level, with the exception of Grade 10. Second, several studies found that there are subgroups of children who experience more than one type of frequent recurrent pain or that having one type of recurrent pain increases the likelihood of experiencing another (Egger et al., 1999; El-Metwally et al., 2006; Ghandour et al., 2004; Groholt et al., 2003; Larsson & Sund, 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Ramchandani et al., 2005). For example, Perquin and colleagues (2000) found that over half of the children with chronic pain reported having more than one type of pain, with headache and stomachache being the most common pair of pains. Research by Groholt and colleagues (2003) also found headache and stomachache to be the most commonly experienced pair of pains. Ghandour and colleagues (2004) found that 46.4% of girls with headaches also experienced weekly stomachaches, and 45% experienced weekly backaches. A third theme is that many studies find that girls have higher rates of recurrent pain than boys (Egger et al., 1999; Groholt et al., 2003; Hakala et al., 2002; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Ramchandani et al., 2005), in fact Larsson and Sund (2005) found recurrent headaches to be about three times more common in girls than boys.

To summarize, recent research investigating the prevalence of recurrent pain in children and adolescents has improved since the review by Goodman and McGrath (1991). However, despite the movement to using population-based research, there are still
methodological challenges that should be improved upon in future research investigating the prevalence of recurrent pain in adolescence. Research is needed that considers multiple types of recurrent pain, uses representative samples that include boys and girls, defines recurrent pain in a manner that allows results to be easily compared to results from other studies, and considers the entire adolescent age range, as this is the time when prevalence rates have been shown to increase. Longitudinal designs will be very important because they allow individual recurrent pain trajectories to be assessed, based on adolescents’ frequencies of recurrent pain at specific points across time. Using trajectories, researchers are able to show what factors predict increasing frequencies of recurrent pain over time, as well as to predict which factors are related to where adolescents start and end on their trajectories. No research to date has mapped the prevalence of recurrent pain in a single sample of adolescents over time and generated individual developmental trajectories for recurrent pain across this time period.

Conceptual Models, Psychosocial Factors and Recurrent Pain

Alongside research on the prevalence of adolescent recurrent pain, research is needed to investigate the psychosocial factors that predict the development of recurrent pain across adolescence. Several of the population-based recurrent pain prevalence studies reviewed above also considered the relationships between psychosocial factors and recurrent pain in adolescence. This research either used cross-sectional designs to find associations between psychosocial factors and recurrent pain, or longitudinal designs where psychosocial factors from one time point were tested for their ability to predict recurrent pain levels at one future time period. Psychosocial models are needed to better understand the development of adolescent recurrent pain, as indicated by individual recurrent pain trajectories, rather than concurrent pain levels or pain levels at one future point in time. Although few conceptual
models currently exist in the literature that are specific to the development of adolescent recurrent pain, there are several models that can provide suggestions for how to integrate psychosocial factors into a model for adolescent recurrent pain. In the section below, models that offer relevant suggestions to a model for the development of adolescent recurrent pain will be presented. Next, the proposed psychosocial model for adolescent recurrent pain will be introduced, and each of the psychosocial factors involved will be discussed in detail.

Existing conceptual models. Many models exist in the literature to describe how psychosocial factors relate to the acute pain experience in children, for excellent examples see McGrath and Gillespie (2001) and Craig and colleagues (Craig, 2002; Craig, Lilley, & Gilbert, 1996; Craig & Pillai Riddell, 2003). Although they do not address recurrent pain, both of these models highlight the importance of psychological factors, such as anxiety, depression and fear, children’s knowledge of social display rules and parents’ experiences with pain in shaping children’s general experiences of pain. These factors may play a role in adolescent recurrent pain as well.

Conceptual models also exist that describe psychosocial factors that can lead to the development of chronic stress in children (Timko, Moos, & Michelson, 1993). Although not specific to adolescent recurrent pain, chronic pain can be thought of as a form of chronic stress, and thus the predictors may overlap. The model by Timko and colleagues (1993) puts forth three types of psychosocial factors that lead to chronic stress: sociodemographic factors, personal factors, and contextual stress and coping factors. Sociodemographic factors include child gender, child age and parent education. Personal factors are the anxiety level, self-worth and temperament of the child. Lastly, conceptual stress and coping factors include
negative life events, social resources and coping style. Thus, it may be important to consider these types of factors in the development of adolescent recurrent pain as well.

The social-ecological model of child health, developed by Kazak and Kunin-Batson (Kazak, 1989; Kazak & Kunin-Batson, 2001) is another model that incorporates the notion of varying contextual levels to help explain the processes involved in how children adapt and cope with having a chronic illness. Kazak and Kunin-Batson’s model integrates Bronfenbrenner’s (1979) social-ecology paradigm with a family systems perspective. In their model, the child is surrounded by the microsystem, the mesosystem, and the exosystem, each representing an increasingly distant level of relationship. The microsystem level encompasses relationships that are the most immediate to the child, such as those between the child, their illness, and their family. At the mesosystem level, relationships are included that occur between the child and their peers, hospital staff, schools and hospitals. The most distant level of influence, the exosystem, contains abstract entities such as culture, social class, and technology. The social-ecological model highlights how the experience of a chronic illness, such as recurrent pain, is shaped by the child’s emotions (e.g., anxiety, self-esteem), their relationships with their parents (e.g., parent’s own experiences of pain), and their larger environment (e.g., pain could be triggered by injury, illness or hospital procedures). These psychosocial factors may also be important to a model of adolescent recurrent pain.

Finally, psychosocial models exist for the development of adult chronic pain. Turk’s (2002) injury-focused model offers suggestions for factors to include in a model for adolescent recurrent pain. In Turk’s (2002) model for the development of adult chronic pain, anxiety sensitivity is considered a predisposing, underlying vulnerability. Injury is considered
a possible trigger of initial pain symptoms. The model suggests that a person with a high level of anxiety sensitivity attributes pain symptoms as being signs of a serious problem. Turk sees psychological factors, such as fear of further pain and injury, catastrophic thoughts about pain, and feelings of low self-efficacy, leading to activity and rehabilitation avoidance. Operant conditioning facilitates the development of disability in the long term.

Unfortunately, Turk’s (2002) model was not designed to address the psychosocial factors that may be important to recurrent pain development specifically in adolescent populations. Despite this, the model does suggest an organizational framework for deriving a model of the development of adolescent recurrent pain. Turk’s model suggests that categorizing psychosocial factors as underlying vulnerabilities, precipitating stimuli, and psychological factors may be a useful framework to apply when developing a model for adolescent recurrent pain. Furthermore, these categories are similar to the sociodemographic, contextual stress and coping, and personal factors proposed in the model by Timko and colleagues (1993).

It is also important to briefly note Walker’s (1999) model for the potential outcomes of RAP in children, as this model is specific to one type of pediatric chronic pain. Walker’s social-learning model stresses activity restriction and whether or not the child develops a sick role. The model emphasizes the importance of social reinforcement, modeling and vicarious learning for RAP. The model highlights the potential for parents to model pain behaviours for children and the influence children’s sense of confidence and self-esteem can play in RAP outcomes. Thus, the presence of parental chronic pain and self-esteem may be important to consider in a model of adolescent recurrent pain development. The Walker
Commonalities across existing models. In order to develop a new model for the development of adolescent recurrent pain, it is necessary to decide what factors from previous models may be relevant. One approach is to look for themes that are common across models. Demographic factors, such as the gender of the child and level of maturational development, are identified as being important factors in many of the models (Craig, 2002; Craig et al., 1996; Craig & Pillai Riddell, 2003; McGrath & Gillespie, 2001; Timko et al., 1993). The concept that parents' experiences of pain influence their children's experiences with pain is also included in multiple models (Craig, 2002; Craig et al., 1996; Craig & Pillai Riddell, 2003; Walker, 1999). Contextual precipitating factors also play a role in several models, specifically stressful life events in the model by Timko and colleagues (1993), injury in the model by Turk (2002) and hospital procedures in the model by Kazak and Kunin-Batson (2001). Psychological factors are present in all of the models. One way to synthesize the common elements and critical variables found across these models would be to group individual psychosocial factors into three categories, in some ways similar to the Turk (2002) model: underlying vulnerability factors (e.g., gender, parent chronic pain), precipitating stimuli (e.g., injury, stressful life events), and psychological factors (e.g., anxiety, self-esteem). Other specific individual psychosocial factors associated with adolescent recurrent pain could be added to this basic model framework.

In summary, it is important to understand the development of recurrent pain by considering individual trajectories of pain over time. Models are needed to explain how psychosocial factors are related to the development of recurrent pain, as indicated by
trajectories over time. Existing models in the literature, while not specific to adolescent recurrent pain, offer ideas about what psychosocial factors may be important to the development of recurrent pain in adolescents and how a model for adolescent recurrent pain might be organized. One of the central goals in the present research was to generate and empirically test a model for the development of adolescent recurrent pain. In the next section, psychosocial factors that have been included across previous conceptual models and/or shown to be associated with adolescent recurrent pain are described and integrated into a conceptual model for the development of adolescent recurrent pain.

Proposed model for psychosocial factors associated with the development of recurrent pain. A model that is similar in some ways to Turk's (2002) model for the development of recurrent pain in adults, is proposed to describe the development of recurrent pain in adolescents. Three types of factors are included in the proposed psychosocial model for the development of adolescent recurrent pain: factors relating to the underlying vulnerabilities that an adolescent possesses, precipitating stimuli that an adolescent encounters, and adolescent psychological factors (see Figure 1). These factors are proposed to exist together and influence whether or not an individual adolescent will develop recurrent pain.

Underlying vulnerabilities. Underlying vulnerabilities may include gender, pubertal status, and having a parent with chronic pain. As mentioned previously, girls have been noted to have higher rates of recurrent pain (Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000), for example headache (Larsson & Sund, 2005), backache (Hakala et al., 2002) and stomachache/RAP (Egger et al., 1999; Ramchandani et al., 2005). Research has noted that the prevalence of recurrent pain surges during adolescence; particularly in girls (Larsson &
Sund, 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000). Pubertal status may underlie the surge in prevalence rates. It has been posited that the hormonal changes associated with the onset of menstruation may be involved, as menstruation is often associated with backache and stomachache (Unruh & Campbell, 1999). Thus, gender and pubertal status are included as part of underlying vulnerabilities to adolescent recurrent pain.

Research has also found that children whose parents have chronic pain are more likely to report abdominal pain and use pain medication (Jamison & Walker, 1992). Boey and Goh (2001a) showed that early-adolescents from urban areas of Malaysia were more likely to have RAP if their parent experienced abdominal pain. In a study of children experiencing chronic pain due to a known cause, children experiencing recurrent pain without a known cause, and children with pain due to sickle cell disease, children with unexplained recurrent pain reported having more pain models, that is significant people in their lives with pain complaints, than other children (Osborne, Hatcher & Richtsmeier, 1989). Parents were the most common type of model reported (Osborne et al., 1989). Further, children and pain models had similar physical pain locations (Osborne et al., 1989). Merlijn and colleagues (2002) found that a group of adolescents with chronic pain due to headache, stomachache, backache and limb pain, also had more pain models than a group of adolescents without chronic pain. In other research, children with juvenile rheumatoid arthritis and their parents were shown to have similar ratings of pain responses to an experimental pain stimulus (Thastum, Zachariae, Scholer, Bjerring, & Herlin, 1997). These findings could be seen as evidence that physiological problems underlying pain, or a physiologically lower pain threshold, can be passed genetically from parent to child. Alternatively, it could be seen as support for children's ability to learn pain behaviours from
parents. Regardless, it appears that having a parent with chronic pain is likely to be an important factor in the development of recurrent pain in adolescents, and is included as another type of underlying vulnerability in the proposed adolescent recurrent pain development model.

Precipitating stimuli. Along with preexisting underlying vulnerability factors, there may also be precipitating stimuli that are related to the recurrent pain trajectories in adolescents. Precipitating stimuli for recurrent pain are proposed to include experiences with injury (Turk, 2002), acute illness/hospitalization, as well as stressful life events. The American Pain Society (2001) acknowledges that chronic pain may develop as a result of acute pain. Injuries are a common source of acute pain. In Turk’s (2002) model, injury is a potentially important factor in the development of chronic pain. However, it should be noted that one study found that the recurrence of limb pain was more likely if it was not due to a traumatic cause (El-Metwally, Salminen, Auvinen, Kautiainen, & Mikkelsson, 2005). The present study will test the role of injury as a precipitating stimulus in the development of recurrent adolescent pain.

Another type of precipitating stimuli for recurrent adolescent pain may be acute illness and hospitalization. Acute illnesses, such as tonsillitis, are a source of acute pain, which could over time evolve into chronic pain. Acute illnesses also frequently lead to hospital stays. Procedures performed as a part of hospitalization are themselves a common source of acute pain. In a sample of 9- to 15-year-old Malaysian early-adolescents, Boey and Goh (2001b) found that higher rates of RAP were seen in participants who had been hospitalized in the past year. Thus, injury and acute illness/hospitalization are proposed to be precipitating stimuli in the development of recurrent pain in adolescents.
One final type of psychological precipitating stimulus may involve stressful life events. Research following children with juvenile rheumatoid arthritis and juvenile spondyloarthropathy over time showed that stressful life events were associated with poorer psychosocial outcomes (Aasland, Flato & Vandvik, 1997). Boey and Goh (2001b) also found that higher rates of RAP were seen in urban-dwelling early-adolescents who experienced a stressful life event in the past year, such as the hospitalization of a family member or a family member changing occupation. Other research by this team found that experiencing the death of a family member and having an immediate family member change occupations were also associated with RAP in a sample of rural-dwelling 9- to 15-year-old early-adolescents (Boey & Goh, 2001c). Although stressful life events, such as moving schools, changes in family living situations, births, and deaths, are not direct causes of physical pain for adolescents, stress has been associated with negative physical health outcomes, such as viral infection, in adults (Cohen, Tyrrell & Smith, 1991). It is possible that experiences with stressful life events alter physiological mechanisms in the body that trigger recurrent pain. It is also possible that the energy required for adolescents to deal with stressful life events drains their resources to cope with and treat pain when it occurs and that this leads to pain reoccurrence.

Psychological factors. Finally, the proposed conceptual model hypothesizes that psychological factors are likely to play a large role in adolescent recurrent pain trajectories (Palermo, 2000; Turk, 2002). Emotions and their associated cognitions are an integral part of experiencing pain (Merskey & Bogduk, 1994). In Turk’s (2002) model of adult chronic pain, psychological factors are crucial in determining whether pain exists beyond the time expected for normal healing and becomes disabling chronic pain. In adolescents, there are several psychological factors known to be associated with recurrent pain. In their studies
using the NLSCY, Gordon and colleagues (Dooley et al., 2005; Gordon et al., 2004) found that adolescent-report of depression and anxiety were strongly related to adolescent headache. In a 5- to 6-year follow-up study of RAP patients and healthy children, Walker and colleagues (1995) found that levels of depression and internalizing behavioural problems were significantly higher in children who had RAP than in those who were healthy. In their study of Finnish school children, El-Metwally and colleagues (2006) found that children with lower limb pain were more likely to have depressed mood than children without limb pain. These findings linking psychological factors and recurrent pain are generally well supported by other research (Egger et al., 1998; Egger et al., 1999; Larsson & Sund, 2005; Mustard et al., 2005). In addition, self-esteem/sense of mastery has been proposed as a key psychological variable in relation to child health (Chen, Matthews & Boyce, 2002) and for the development of adult disabling chronic pain (Turk, 2002). In their NLSCY studies, Gordon and colleagues (Dooley et al., 2005; Gordon et al., 2004) found that adolescent-reported general self-esteem was one of the psychosocial factors associated with headaches. Depression, anxiety and low self-esteem/mastery may act as barriers to adhering to treatment programs among adolescents struggling with pain. Thus, depression, anxiety and self-esteem are proposed as psychological factors that will predict trajectories of recurrent pain over time in adolescents.

In summary, there are three types of psychosocial factors that are likely to be involved in the development of adolescent recurrent pain: underlying factors, precipitating factors and psychological factors. Underlying factors that may be associated with a higher risk of developing pain include gender, pubertal status and parent chronic pain. Key precipitating factors include injury, acute illness, and stressful life events. Lastly,
psychological factors, specifically anxiety, depression, and low self-esteem, may also propel the development of recurrent pain in adolescents (see Figure 1).

Key Elements in Future Research on Psychosocial Models for Adolescent Recurrent Pain Development

Longitudinal designs. There are three design elements that are essential in future research on the development of recurrent pain. First, research should be longitudinal. Longitudinal designs are important for several reasons. Research using cross-sectional designs is not able to tease apart the possible directions of association between pain and psychosocial factors. Just as psychological factors, such as anxiety, depression and self-esteem, are likely to play an important role in the development of recurrent pain, recurrent pain is likely to result in increases in anxiety and depression, as well as lowered self-esteem. For example, depression is likely to help cause an injury to become a increasingly recurrent pain condition, and having recurrent pain is also likely to cause worsening depression. The present research will focus on determining which psychosocial factors prospectively predict the development of recurrent pain.

Research is needed that goes beyond considering what psychological factors are associated with concurrent frequency of pain or frequency of pain at a single future time point, but that investigates the development of recurrent pain, using recurrent pain trajectories over time. Longitudinal designs allow trajectories to be modeled. Factors can then be tested for their ability to predict individual differences in trajectories. For example, factors predictive of individual differences in both the start- and end-point intercepts of recurrent pain trajectories would provide information about what is associated with high frequencies of recurrent pain at the beginning and end of adolescence, suggesting pain that is
maintained over time. Factors predictive of individual differences in recurrent pain trajectory slopes would provide information about which adolescents are more likely to develop increasingly higher frequencies of recurrent pain over time.

Multiple types of recurrent pain. Second, it is important to recognize that there are different types of recurrent pain common in adolescence, such as headache, stomachache and backache (Goodman & McGrath, 1991; Groholt et al., 2003; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000). As was stated above, many studies have shown that it is common for some children to experience multiple types of recurrent pain (Boey & Goh, 2001a; Egger et al., 1999; El-Metwally et al., 2006; Ghandour et al., 2004; Groholt et al., 2003; Larsson & Sund, 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000; Ramchandani et al., 2005). Future research must study the prevalence of multiple types of recurrent pain and determine the rates at which they co-occur. Further, research on adolescent recurrent pain trajectories needs to determine whether or not specific psychosocial factors are relevant for specific types of recurrent pain, or whether a general psychosocial model can describe the development of all types of recurrent pain.

Predictor strength. Lastly, it is important for future models to determine which psychosocial factors are, statistically, the strongest predictors of the development of recurrent pain trajectories by conducting analyses that include multiple potential predictors simultaneously. Factors that are predictive only when considered independently are statistically weaker than those that are predictive when all psychosocial factors are considered simultaneously. However, these factors may be very important from an intervention perspective, if they are easy to identify, measure and/or address in treatment.
Summary

In summary, pain is a common and disabling condition for children and, during adolescence, rates of recurrent pain climb steeply. Further research is needed to explore recurrent pain prevalence in a population-based sample that spans adolescence. Models are needed to integrate psychosocial factors that are likely to be involved in the development of recurrent pain. Longitudinal methods are required to allow individual recurrent pain trajectories to be mapped. Testing models should involve determining which psychosocial factors are associated with high rates of recurrent pain that are maintained over time (i.e., trajectory start- and end-point intercepts), as well as with change in recurrent pain prevalence rates over time (i.e., trajectory slopes). The long-range goal of future research will be to ultimately prevent or, at least, help ease suffering among adolescents with recurrent pain.

Study Design

The National Longitudinal Survey of Children and Youth (NLSCY; Statistics Canada, 1995) provides an invaluable resource for future research on the prevalence, trajectories and predictors of recurrent pain across adolescence. With the application of survey weights, data from the survey is representative of the nation. The secure version of the data permits longitudinal analyses. Cohorts in the survey were assessed every 2 years. Questions on recurrent pain pertain to headache, stomachache and backache and were asked of children from the ages of 12 to 19 years. Thus, recurrent pain prevalence can be studied over the course of adolescence. Further, trajectories can be created to represent the development of recurrent pain across this time period. The survey contains data from adolescents, parents and teachers on a wide range of demographic, emotional, health,
lifestyle and school-related variables. Thus, the conceptual model proposed was tested in this dataset for its ability to predict adolescent recurrent pain trajectories.

A nationally representative group of 10- to 19-year-old adolescents from the NLSCY comprised the main sample of interest. Participants were studied five times over 10 years, first at 10-11 years and every 2 years subsequently, and were asked about headache, stomachache and backache from the time they were 12-13 years onward. This sample age range was ideal because it spans the time during which recurrent pain shows an increase in prevalence (Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000). These types of recurrent pain were ideal because they are known to be common types of pain in childhood and adolescence (Goodman & McGrath, 1991; Groholt et al., 2003; Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen et al., 2000).

**Purpose, Specific Aims and Hypotheses**

The overarching purpose of this research was to add significantly to the understanding of recurrent pain among adolescents by conducting a longitudinal population-level investigation of the prevalence, trajectories and predictors of adolescent recurrent pain. The present study had two major aims. The first aim of the study was to illustrate the prevalence of recurrent headache, stomachache and backache across the adolescent time period. Prevalence was studied by considering rates of headache, stomachache and backache reported by the cohort at ages 12-13, 14-15, 16-17, and 18-19 years. In keeping with the results of previous literature, it was expected that rates of recurrent pain would increase with age, that there would be a subgroup of adolescents who experienced more than one type of recurrent pain and that girls would show higher rates of recurrent pain than boys.
The second objective of this research was to test a comprehensive psychosocial model for the development of adolescent recurrent pain (see Figure 1). The recurrent pain development model included elements suggested by theory and empirical findings. Individual variables included: underlying vulnerabilities (i.e., gender, pubertal status, and parent chronic pain), precipitating stimuli (i.e., injury, acute illness, and stressful life events) and psychological factors (i.e., anxiety, depression, and self-esteem). Testing the recurrent pain development model involved generating trajectories for each adolescent based on their frequencies of recurrent pain over four time points (at ages 12-13, 14-15, 16-17, and 18-19 years), and then determining which psychosocial factors were associated with high rates of recurrent pain at the beginning and end of adolescence (i.e., trajectory start- and end-point intercepts), as well as with increasing pain levels over time (i.e., trajectory slopes). All psychosocial factor data were temporally precedent to the data that were used to create the recurrent pain trajectories. This was done in order to strengthen the study's ability to infer directionality between the psychosocial predictors and the recurrent pain trajectories. Headache, stomachache and backache were tested independently.
Method

Participants

The participants for this study were a cohort of 2,488 adolescents in the NLSCY (see description below). These children were among those originally randomly selected for participation in the NLSCY from the Statistics Canada Labour Force Survey (LFS; Statistics Canada, 1990) in order to create a sample that represented a 4% national prevalence rate for each child age in years. The NLSCY sample was also chosen to be representative of the Canadian population in terms of geographic location (all provinces and territories were represented in the sample), family socioeconomic status (SES), ethnicity, etc. It is important to note that families with children living on Native reserves or in institutions were not included in the LFS and, as such, were not part of the NLSCY sample. NLSCY participants were not paid.

Sample survey weights. Statistics Canada creates survey weights in order to ensure that the results of studies generated from their survey data are representative of the nation or of individual provinces. When doing analyses, survey weights make one participant in the survey count for the number of individuals in the country that match the participant’s demographic profile at a given time, for example a Caucasian male participant would have a larger survey weight than a female participant from a small ethnic minority group because the Caucasian male participant represents many more people in the population as a whole. In other words, survey weights make a sample representative of a larger population, based on the demographics of that population at a given time. The NLSCY contains survey weights for each of the 2-year periods during which data collection was completed (Cycle 1: 1994-1995, Cycle 2: 1996-1997, Cycle 3: 1998-1999, Cycle 4: 2000-2001, Cycle 5: 2002-2003). Many
demographic factors are considered when survey weights are created, such as ethnicity, SES, gender, and age.

There are several types of survey weight variables included in the NLSCY. In this project, national longitudinal survey weights were applied given the nature of the study design. As per recommendations for longitudinal research, longitudinal survey weights from the first time-period the cohort was studied were used.

As well, non-normalized or normalized survey weights are available. Non-normalized survey weights cause the sample size to be reflective of the population size and are recommended for descriptive analyses. In normalized survey weights, the sum of all the individual participants' survey weights is equal to the actual number of individuals in the survey sample, and the mean of all the survey weights is 1.0. Normalized survey weights are recommended when inferential statistics are used. Their application ensures that the sample size for one analytic procedure is not excessively large, which would be the case if non-normalized survey weights were applied. These recommendations regarding when to apply non-normalized versus normalized survey weights were followed throughout the data analysis process for this project.

To summarize, national longitudinal survey weights from Cycle 1 (either non-normalized for descriptive analyses, or normalized for inferential analyses), were applied during data analytic procedures, with exceptions made only when it was desirable to provide the reader with descriptive information about the raw/unweighted cohort. The application of the national longitudinal Cycle 1 survey weights makes the results of this study representative of the Canadian population in 1994-1995, the time period in which the cohort of interest was initially compiled.
Cohort description. The specific sample of interest in the present research was comprised of adolescents who were studied longitudinally from ages 10-11 years to ages 18-19 years (unweighted $N$ at Cycle 1 = 2,488). When the Cycle 1 non-normalized national longitudinal survey weight was applied, the Cycle 1 sample represented 792,192 participants (48.7% girls). Adolescents were sampled five times, approximately every 2 years, in Cycles 1-5. Adolescents who were not included in the first cycle of data collection, but were added to the survey in subsequent cycles, were not included in the cohort. After Cycle 1, adolescents in the cohort could have missed any of the four subsequent cycles of data collection. See Table 2 for age and gender statistics about the cohort at the five cycles of data collection. Although there was some variation in age across cycles, the cohort was basically 10-11 years in Cycle 1, 12-13 years in Cycle 2, 14-15 years in Cycle 3, 16-17 years in Cycle 4, and 18-19 years in Cycle 5. To ease interpretation, adolescents will be referred to by these ages, rather than by Cycle throughout the rest of the study; only survey weights will be described in terms of cycle. In terms of ethnicity, results obtained using the Cycle 1 non-normalized national longitudinal survey weight (weighted $N = 698,377$) indicated that the cohort was 91.1% Caucasian, 2.4% South Asian, 1.4% Black, 1.6% Native, and 2.5% Arab, Latin American or other ethnicity. Because the weighted sample was predominantly Caucasian, future analyses based on ethnicity were not considered. A primary caregiver was also considered for every adolescent in the cohort. Although the primary caregiver did not have to be a parent, the majority were (results using the Cycle 1 non-normalized national longitudinal survey weight, 89.9% were birth mothers, 7.9% were birth fathers, 2.1% were step-parents, adoptive parents, or other related female) and will be referred to as caregivers or simply parents throughout this paper. In terms of the SES of families in the cohort, results
obtained using the Cycle 1 non-normalized national longitudinal survey weight showed that the mean yearly household income, in thousands of dollars was 50.60 (weighted \( N = 792,192; SD = 24.02 \)). Again using the Cycle 1 non-normalized national longitudinal survey weight, the mean number of years of education for mothers and fathers was found to be 12.40 (weighted \( N = 769,419; SD = 2.36 \)), and 12.69 (weighted \( N = 645,359; SD = 2.84 \)), respectively. There is no variable in the NLSCY that denotes participants as being siblings of one kind of another (e.g., biological sibling, step-sibling). Using the Unique Household Identification variable (AIDHOLD) as a proxy for sibling status, it was determined that there were very few adolescents in the cohort who shared a household (unweighted number of adolescents sharing a household at age 10-11 years: 77, age 12-13 years: 69, ages 14-15 years: 63, age 16-17 years: 55, age 18-19 years: 23). Since these numbers were so low, relative to the overall unweighted cohort size, future analyses did not consider whether or not participants shared a household.

This cohort was chosen for several reasons. At age 10-11 years, children are just about to enter their teenage years and are an ideal sample for studying recurrent pain over the course of adolescence. This was also the first age group that was administered self-report questionnaires in the survey. Although the first cycle of data collection did not include items about recurrent pain, all four subsequent cycles did ask adolescents to report on recurrent pain. Lastly, this cohort was selected because it was the only cohort in the NLSCY that was surveyed using self-report questionnaires at five time points. Other adolescent cohorts do exist in the survey but they have four cycles of self-report data, or less. In other words, this cohort was selected because it was the longest studied adolescent cohort with self-report data in the longitudinal survey.
Procedure

The NLSCY is a longitudinal-sequential survey (Statistics Canada, 1995). (For a detailed description of the NLSCY data collection procedures and measures please see: http://www.statcan.ca/cgi-bin/downpub/listpub.cgi?catno=89F0078XIE2004001). The survey was conducted across five 2-year cycles, with the first cycle of data collection (1994-1995), including a cohort of children between ages 0-11 years. In subsequent cycles, infants were added to the sample so that the 0- to 1-year-old age range was represented at each cycle. Children who were part of the original Cycle 1 0- to 11-year-old longitudinal cohort were studied at each subsequent cycle and will be studied until they are 25 years old. As was described above, this study drew its cohort from the group of 10- to 11-year-olds included for the first time in Cycle 1 of the survey, and who were then studied longitudinally.

At the outset of the survey, children and their primary caregiver provided consent that their data could be used for research purposes. At each cycle, data collection involved multimethod, multirater techniques. Computer-assisted interviews were conducted in the home or over the telephone with children's primary caregiver and children over 16 years. Children aged 10 years and older were administered a self-report questionnaire. Children's school principals and classroom teachers also completed questionnaires.

Measures

Data collected at each cycle of the NLSCY pertained to a broad range of child, parent and family variables. The Canadian Research Institute for Social Policy (CRISP) NLSCY files (Willms & Fedick, 2003) were used to complete this study. The CRISP NLSCY files are a user-friendly version of the original Statistics Canada NLSCY data files. All of the original NLSCY data is present along with several created index and scale variables (e.g., for SES).
Only the measures for variables pertaining to the present study will be described further. See Table 3 for a summary of variables in the pain development model. It is important to note that all psychosocial factor data was obtained from Cycle 1, when the cohort was 10-11 years old, making it temporally precedent to the data that was used from Cycles 2-5, when the cohort was between the ages of 12-13 years and 18-19 years, to create the recurrent pain trajectories. Any descriptive analyses reported in this section were obtained using the non-normalized national longitudinal survey weights and, as is required by Statistics Canada, had cell sizes of at least \( n = 5 \) in unweighted versions of analyses. Inferential analyses were completed using the normalized national longitudinal survey weights. Throughout the section below, measures of internal consistency will be reported for scales whose items were intended to describe an underlying psychological construct, but not for scales where individual items represent discreet physical events, health conditions, or life experiences.

**Demographic variables.** Ethnicity information about the cohort was assessed from the Cycle 2 (cohort age = 12-13 years) parent-report variable BSDCB4AA-AL. This question asked parents “How would you describe (the child’s) race or colour?” Parents could indicate more than one ethnic category. Data from Cycle 2 (cohort age = 12-13 years) was taken because this question was not included in Cycle 1. The 1991 Census was used to generate items on family income. Yearly household income in thousands of dollars was obtained from variable AH005. NLSCY items on caregiver education were derived from Statistics Canada’s General Survey on Work and Education. Number of years of education was obtained for adolescents’ mothers and fathers from variables AH004A and AH004B, respectively. Information regarding the primary caregiver’s relationship to the adolescent was obtained.
from variable ADMCD06. Categories for “adoptive mother” and “other related female” were collapsed in order to achieve unweighted cell size of $n = 5$.

Recurrent pain. Recurrent pain was assessed via adolescent-report, and was only included in the NLSCY in Cycles 2-5 (cohort ages = 12-13 years – 18-19 years). The questions on pain were derived from the World Health Organization’s Health Behaviors in School Children Survey. Adolescents were asked “In the past six months, how often have you had or felt the following: (a) headache..., (a) stomachache..., (a) backache...?” Adolescents responded using a 5-point Likert-type ordinal scale that included: 1 (seldom or never), 2 (about once a month), 3 (about once a week), 4 (more than once a week) and 5 (most days). Adolescents between 12 and 15 years answered pain questions as part of their paper-and-pencil “Health Questionnaire”. Children 16 years of age and older completed them using a computer-assisted version of the questionnaire. Data from Cycles 2-5 (cohort ages = 12-13 years – 18-19 years) were included to create the recurrent pain trajectories. Detailed information about recurrent pain data for the cohort can be found in the Results section below.

Underlying vulnerability factors. Adolescent gender, pubertal status and parent chronic pain were considered to be potential underlying vulnerability factors for the development of recurrent adolescent pain. Adolescent gender was measured via parent-report as a basic demographic variable. Gender proportions for the cohort at each cycle/age group are found in Table 2. In analyses testing the adolescent pain development model, the specific gender variable AC002 was used. This variable was recoded so that (girls = 1) and (boys = 0).
Pubertal status items were completed by adolescents on self-report items BPUCQ01-05 within the paper-and-pencil “Health Questionnaire”. Both boys and girls were asked “Would you say your body hair has begun to grow?” Boys were also asked “Have you noticed a deepening of your voice?” and “Have you begun to grow hair on your face?” Girls were asked “Have your breasts begun to grow?” These items were answered using a 4-point Likert-type scale that included 1 (has not started), 2 (barely started), 3 (definitely underway), and 4 (seems completed). Girls were also asked a yes/no question about whether they had begun menstruation. A mean score for pubertal status, ranging from 0.0-1.0, was created similar to the method used by Holly (2004) where higher scores indicated more advanced pubertal development. First, items for body hair, voice, facial hair and breasts were recoded to be dichotomous by collapsing Likert-scale responses 2, 3, and 4. For girls, the mean score included the body hair, breasts, and menstruation items. The boys’ mean score included the body hair, voice and facial hair items. Adolescents had to provide responses on at least two of their items in order to obtain a mean score, because missing data analyses indicated that this would capture 100% of the sample.

Parent chronic pain was measured via parent-report on the “Adult Health Questionnaire”: “… ‘long-term’ conditions refer to conditions that have lasted or are expected to last 6 months or more. Do you have any of the following long-term conditions that have been diagnosed by a health professional?” Parents responded yes or no to a list of chronic conditions (0 = no, 1 = yes). Only the following conditions typically associated with chronic pain were considered: “arthritis or rheumatism” (variable BCHPQ1D), “back problems, excluding arthritis” (variable BCHPQ1E), “migraine headaches” (variable BCHPQ1G), “sinusitis” (variable BCHPQ1I), “cancer” (variable BCHPQ1M), and “stomach
or intestinal ulcers” (variable BCHPQ1N). The chronic condition items were derived for use in the NLSCY from the National Population Health Survey. A mean total score for parental chronic pain, ranging from 0.0-1.0, was obtained, where higher scores indicated a higher number of chronic pains experienced by parents. Parents were required to provide responses for all of the items in order to receive a mean score because missing data analyses indicated that 99.7% of parents had reported on all items and the remaining 0.3% had not responded to any. The “migraine headaches” item was also included as a single-variable predictor in the adolescent recurrent headache development model. The same was done for “stomach or intestinal ulcers” in the adolescent recurrent stomachache development model, and for “back problems, excluding arthritis” in the adolescent recurrent backache development model.

**Precipitating factors.** Precipitating factors included injury, acute illness, and stressful life events. Injury was quantified using the scoring method similar to the one used by Curtis, Dooley and Phipps (2004) for nonsports related injuries. The frequency of injury was obtained by calculating the number of times caregivers reported on the “Child Health Questionnaire” that their adolescent had injuries “in the past 12 months, and were serious enough to require medical attention from a doctor, nurse, or dentist” (variable AHLCQ38). These items were derived from items on the National Population Health Survey. Acute illness/hospitalization was measured by caregiver-report on two items in the “Child Health Questionnaire”. Caregivers stated whether or not their child had stayed overnight in the hospital in the past year (variable AHLCQ49; 0 = no, 1 = yes), and indicated whether the reason for hospitalization was due to “respiratory illness”, “gastrointestinal illness or disease”, “injury”, or “other” (AHLCQ50). These questions were adapted for use in the NLSCY from the items in the Ontario Population Health Study (Statistics Canada, 1999).
Inpatient stays due to injury were excluded for this acute illness/hospitalization variable. Adolescents’ experiences with stressful life events were measured in the NLSCY via caregiver-report on questions in the “Child Health Questionnaire” (variables AHLCQ52B-O). Parents stated whether their child had “ever experienced any event or situation that has caused him/her a great amount of worry or unhappiness” and indicated what type of events these were from a list of choices that included “death of parents”, “death in family other than parents”, “divorce/separation of parents”, “move”, “stay in hospital”, “stay in foster home”, “other separation from parents”, “illness/injury of child”, “illness/injury of a family member”, “abuse/fear of abuse”, “change in household members”, “alcoholism or metal health disorder in family”, “conflict between parents”, and “other”. These questions were developed for use in the NLSCY. A mean score, ranging from 0.0-1.0, was created, where higher scores indicated more stressful life experiences. Missing value analyses indicated that 99.2% of parents had completed all items in the mean score, and the remainder had completed none at all.

**Psychological factors.** Adolescent psychological factors were also proposed to be involved in the development of recurrent pain. The presence of anxiety and/or depression was measured via adolescent-report on the emotional disorder scale within the “Feelings and Behaviours Questionnaire”, originally developed for the Ontario Child Health Study (Statistics Canada, 1999). The reliability and validity of the questionnaire has been shown previously (Boyle et al., 1993). The emotional disorder scale is composed of eight anxiety/depression-related items: “I am unhappy sad or depressed”, “I am not as happy as other children”, “I am too fearful or anxious”, “I am worried”, “I cry a lot”, “I feel miserable, unhappy, tearful, or distressed”, “I am nervous, highstrung or tense”, and “I have trouble
enjoying myself” (variables AD1CQ1F, K, Q, V, CC, II, MM, and RR respectively). Adolescents responded on a 3-point scale that included 1 (never true), 2 (sometimes or somewhat true), and 3 (very or very often true). A mean score, ranging from 1.0-3.0, was created were higher scores indicated higher anxiety/depression. Because missing data analyses showed that 80.4% of adolescents responded to all of the items, it was decided that adolescents had to respond to all eight items in order to obtain a mean score. The Cronbach’s alpha for the adolescent-report emotional disorder scale was 0.77, indicating a strong level of internal consistency in the scale. Anxiety/depression mean scores were also calculated using parent-report (variables ABECQ6F, K, Q, V, CC, II, MM, and RR) and teacher-report (variables AETCQ27F, K, Q, V, CC, II, MM, and RR) data. Parents and teachers were asked to report on the same eight items, in relation to the adolescent. Missing data analyses indicated that 99.8% of parents had responded to all of the items in the scale, and the remainder had not responded to any. In the process of NLSCY data collection, teacher data was not easily accessible. Thus, it was not surprising that missing data analyses indicated that 50.9% of teachers had completed all items in the emotional disorder scale, and 46.9% had completed none. Both parents and teachers were required to have completed all eight items in order to receive an anxiety/depression mean score. The Cronbach’s alpha for the parent-report and teacher-report emotional disorder scale were 0.83 and 0.87 respectively, again indicating strong levels of internal consistency. Adolescent-report, parent-report, and teacher-report anxiety/depression scores were included as separate predictors in order to determine if the different reporters related in different ways to the development of adolescent recurrent pain and because this strategy was recommended due to the large amounts of missing teacher-report data (Holmbeck, Li, Schurman, Friedman, & Coakley, 2002).
Self-esteem was measured using the 4-item general self scale of the Self Description Questionnaire (Marsh, 1990; Marsh, Barners, Cairns, & Tidman, 1984) which is embedded in the adolescent-report “About Me Questionnaire”. Items on the scale included: “In general, I like the way I am”, “Overall, I have a lot to be proud of”, “A lot of things about me are good”, “When I do something, I do it well” (variables AC1CQ01A-D). Adolescents responded on a 5-point Likert-type scale that included 1 (false), 2 (mostly false), 3 (sometimes true/sometimes false), 4 (mostly true), and 5 (true). This questionnaire has been previously shown to have strong reliability and validity (Marsh, 1986; Marsh, Parker, & Smith, 1983). A mean self-esteem score, ranging from 1.0-5.0, was created, where higher scores indicated higher self-esteem. Missing data analyses indicated that 83.6% of adolescents responded to all four items, and that 14.6% did not respond to any items. So, it was decided that adolescents needed to have completed all four items in order to receive a mean score. The Cronbach’s alpha for the scale was 0.76, indicating moderately strong levels of internal consistency.

Data Analysis

Recurrent pain prevalence. The first objective of this research was to investigate the prevalence of recurrent pain in a cohort of adolescents studied throughout their teenage years. It was predicted that there would be some differences in prevalence rates for headache, stomachache and backache, that there would be evidence of adolescents experiencing more than one type of pain, that frequency of weekly recurrent pain would be higher at the end of adolescence than at the start, and that there would be higher frequencies of recurrent pain in girls compared to boys.
The prevalence of recurrent headache, stomachache and backache in the cohort were determined by examining the three recurrent pain frequency variables across all the cycles where data for these variables were present (i.e., Cycles 2-5), allowing the prevalence of pain across ages 12 to 19 years to be illustrated. The prevalence rates for adolescents experiencing more than one type of recurrent pain on a weekly basis were also determined for each cycle of data collection. This was done by collapsing the original 5-point Likert-type ordinal scale values into values representing 0 (*less than weekly*) and 1 (*weekly or more*). Then, the new dichotomous weekly headache and stomachache variables could be summed and adolescents with a score of 2 were known to experience both types of pain on a weekly basis. This process was repeated for all possible pairs of pain-type. In order to ascertain the number of adolescents who experienced all three types of pain on a weekly basis, the dichotomous weekly headache, stomachache and backache variables were summed. Adolescents who received a score of 3 were known to experience all types of pain on a weekly basis. The non-normalized national longitudinal survey weight was applied to obtain prevalence data. Prevalence data was calculated for boys and girls separately. In order to complete these analyses, the 4 (*about once a week*) and 5 (*almost every day*) Likert-scale levels had to be collapsed in order to maintain cell sizes of over \( n = 5 \) in all underlying gender-separated prevalence analyses. Because the pain prevalence data were obtained from ordinal or dichotomous data, Chi-square tests were performed for all prevalence data, at all cycles, to determine whether there were significant differences in patterns of pain prevalence data between the two genders. These inferential tests were done using the Cycle 1 normalized national longitudinal survey weight.
Recurrent pain development model. The second objective of this research was to test a comprehensive psychosocial model for the development of adolescent recurrent pain (see Figure 1). It was hypothesized that a common psychosocial model would be applicable to the development of recurrent pain, but that slightly different sets of factors included within the model would be involved in the development of the three different types of recurrent pain.

Basic descriptive data analyses. Basic descriptive data (e.g., means and standard deviations) were calculated for all psychosocial factors in the recurrent pain development model. Correlations among psychosocial factors in the model were also calculated.

Model testing analyses. Latent variable structural equation modeling (SEM), using Mplus version 3.13 software (Muthen & Muthen, 2003), was used to test the recurrent pain development models. SEM was the most appropriate statistical technique to accomplish our objectives because it allows researchers to create latent trajectories for adolescents’ frequencies of recurrent pain over time and then determine what predictors are associated with components of the trajectories (e.g., intercepts and slopes). Mplus was the ideal software package to choose for these analyses because it is able to apply survey weights, create latent trajectories based on ordinal data, handle non-normality, and deal with missing data in large datasets. Specifically, full information maximum likelihood procedures, using numerical integration, were used to handle missing data in the present study. This technique uses all the available data to estimate model parameters. The procedure adjusts standard errors and model Chi-square tests to account for the possibility of non-normality in the continuous variables. Trajectories were specified to be comprised of ordinal data.

One disadvantage of Mplus is that it is not able to handle data with variant sampling over time (e.g., data where there are differences in the amount of time between data
collection point 1 and 2 across participants). HLM software is able to handle variant sampling data, but is not able to handle missing independent variable data. In the NLSCY, there are varying amounts of time between when participants were surveyed (e.g., Participant 1 may have had a 24-month gap between when their Cycle 1 and Cycle 2 data were collected, while Participant 2 may have had a 20-month gap between their Cycle 1 and Cycle 2 times) although generally there was 24 months between cycles for adolescents in the cohort. Thus, it was important to determine whether time variance was relevant in the data for this study. Results from trajectory modeling in HLM determined that there were no differences in trajectories when time-variant or time-invariant indicators of time were used as the temporal index. Thus, using a time-invariant indicator and proceeding with Mplus for all further analyses was acceptable. It is also important to note that there were no differences in intercept or slope variances between the trajectories produced in HLM versus those produced in Mplus.

An important step in evaluating models run using SEM techniques involves testing the degree to which models match or fit the raw data. There are two types of statistics that are typically used to evaluate model fit: the overall model test statistic and goodness-of-fit indices. The test of overall model fit answers the question: “Is the model different from the data?” Nonsignificance indicates that there is a good match to the data. Overall model tests are highly sensitive to differences between the model and the data, especially when large sample sizes are employed. For ordinal data, Mplus version 3.13 uses the Likelihood Ratio Chi-square test as a means of assessing overall model fit. It was expected that overall model tests would yield significant results in the present study because the sample size was so large. Goodness-of-fit indices answer the question: “How well or how poorly does my model fit the
Numerous goodness-of-fit indices exist, including the root mean square error of approximation (RMSEA), the Chi-square goodness-of-fit test, the goodness-of-fit index (GFI), and the normed or non-normed fit index (NFI; NNFI). It is important to note that Mplus version 3.13 does not produce goodness-of-fit indices when numerical integration procedures are applied to data that contain a combination of continuous and categorical/ordinal data, as was the case in the present study. The combination of expecting that, due to large sample sizes, overall model fit statistics would be significant, and the unavailability of goodness-of-fit indices, meant that evaluations of model fit had to be done in a thoughtful and tentative manner. In the Results section below, tests of model fit are reported for the basic headache, stomachache and backache trajectory analyses. Analyses where psychosocial factors were tested did not alter overall model fit, and thus, no further tests of model fit are reported.

Testing the recurrent pain development model using Mplus involved, first, generating latent trajectories, across the four time points (Cycles 2-5, cohort ages 12-13 years – 18-19 years). Trajectories were created separately for headache, stomachache and backache. Before proceeding with analyses involving psychosocial factors, it was important to establish the shape of the trajectories (e.g., testing whether the slopes had quadratic components). Next it was necessary to determine whether there were significant variances in the intercepts and the slopes across individuals’ trajectories. This would justify attempting to predict variance in trajectories using the psychosocial factors in the recurrent pain development model. A further set of analyses was conducted in order to determine the relationships between the start- and end-point intercepts, as well as the slopes of the basic headache, stomachache and backache growth curves.
The next step in testing the model involved adding psychosocial predictors to the basic trajectory models and assessing whether or not factors were significantly associated with the trajectory start-point intercepts. All predictor data were drawn from Cycle 1, when the cohort was 10-11 years of age. Predictors of trajectory end-point intercepts were assessed by reversing the trajectories’ temporal indexes. Rather than having Cycle 2 (cohort age = 12-13 years) pain data be the first point in the trajectory, Cycle 3 (cohort age = 14-15 years) pain data be the second point in the trajectory, and so on, Cycle 5 (cohort age = 18-19 years) was made the first point, Cycle 4 (cohort age = 16-17 years), the second and so forth. The results of these reverse time-coded models showed what psychosocial factors were associated with the recurrent pain when adolescents were 18-19 years. By comparing the results from the original recurrent pain models (i.e., start-point intercept models) to the models where time coding had been reversed (i.e., end-point intercept models), predictors that were associated with both the start- and end-points of trajectories could be determined and interpreted as factors likely to be important for adolescents who maintain high frequencies of recurrent pain over time. This was a novel way of assessing individuals with high, stable trajectories.

Trajectory slopes were obtained as part of the data generated when the trajectory start-point intercepts were assessed. Factors that were associated with the slope of the trajectories could be interpreted as factors that were associated with the development of increasing rates of recurrent pain over time. In all model testing analyses, psychosocial factors were tested separately, as well as simultaneously in the same model. Factors predictive in simultaneous models were considered to be statistically stronger predictors than factors that were only significant when tested separately.
When investigating the predictors’ start- and end-point intercepts, as well as slopes, gender-by-predictor interactions were also tested. The rationale behind testing gender-by-predictor interactions was based on previous literature suggesting that girls had higher prevalence rates of recurrent pain (Egger et al., 1999; Groholt et al., 2003; Hakala et al., 2002; Larsson & Sund, 2005; Perquin, Hazebroek-Kampschreur, Hunfeld, & Bohnen, 2000; Ramchandani et al., 2005) and wondering whether there might be psychosocial factors that were specifically important for the development of recurrent pain in girls versus boys. Interaction terms were created by multiplying the gender and predictor variables. Interactions were tested by running models that included gender, the predictor and the gender-by-predictor interaction variable.
Results

Recurrent Pain Prevalence

Differences in headache, stomachache and backache prevalence rates. The first objective of this research was to investigate the prevalence of recurrent pain in a cohort of adolescents studied throughout their teenage years. High rates of recurrent pain were seen across adolescence. Overall, headaches were the most common type of recurrent pain. Rates for headaches experienced weekly or more frequently ranged from 26.2-31.8% across the age groups (see Figure 2). Rates for weekly backaches ranged from 17.6-25.8% (see Figure 3). Weekly stomachaches were the least common, with reports ranging from 13.5-22.2% (see Figure 4).

Prevalence rates across adolescence. In keeping with predictions, overall weekly prevalence rates were higher at the end of adolescence (18-19 years, Cycle 5) than they were at the beginning (12-13 years, Cycle 2) for headache and backache (see Figures 2 and 4). Contrary to predictions, weekly stomachache prevalence was not higher at 12-13 years than 18-19 years (see Figure 3).

Multiple pains. The prevalence rates of different combinations of pain weekly or more frequently are reported in Figure 5. Headache and stomachache was the most commonly experienced pair of weekly recurrent pains during the first half of adolescence, experienced by 11.8% of adolescents at 12-13 years and 14.7% at 14-15 years. Headache and backache was the most commonly experienced pair of weekly recurrent pains during the later half of adolescence, reported by 10.2% of adolescents at 16-17 years, and 10.5% at 18-19 years. Stomachache and backache was the least common pair of weekly recurrent pains across all of adolescence. There were a substantial number of adolescents who experienced
all types of recurrent pain on a weekly basis (6.3% at 10-11 years, 8.6% at 14-15 years, 3.6% at 16-17 years, 3.6% at 18-19 years).

**Gender differences.** In order to test gender differences in recurrent pain prevalence, Chi-square analyses were conducted using the normalized national longitudinal survey weights. The 4 (about once a week) and 5 (almost every day) Likert-scale levels had to be collapsed in order to maintain cell sizes of over $n = 5$ in prevalence analyses. Chi-square analyses supported the hypothesis that girls would report higher frequencies of pain than boys. There were significant differences in patterns of reported pain prevalence between girls and boys, for all types of pain and at all cycles of data collection across adolescence, with girls reporting higher frequencies of pain than boys (see Figures 6-8).

**Recurrent Pain Development Model Analyses**

The second objective of this research was to test a comprehensive psychosocial model for the development of adolescent recurrent pain (see Figure 1). All analyses used in testing the recurrent pain development model involved the normalized national longitudinal survey weight. The means and standard deviations, as well as the correlations among the psychosocial variables included in the recurrent pain models are reported in Table 4.

**Trajectories for headache, stomachache, and backache.** Testing the recurrent pain development model involved generating latent trajectories across the four time points (Cycles 2-5, cohort age = 12-13 years – 18-19 years). Trajectories were created separately for headache, stomachache and backache. First, to determine the shape the trajectories took over time, preliminary trajectory models were created that included both linear and quadratic slope components.
The next step was to determine whether there was significant individual variance in the latent trajectory slopes and intercepts. Significant variance would be an indication that these elements could potentially be predicted by factors such as the psychosocial variables proposed. There was significant variance associated with the intercepts of the headache, stomachache and backache trajectories, indicating that there were significant differences in the start-points of pain trajectories across participants (Headache: start-point intercept variance estimate = 2.98, \(SE = 0.30, p < 0.001\); Stomachache: start-point intercept variance estimate = 2.26, \(SE = 0.27, p < 0.001\); Backache: start-point intercept variance estimate = 1.96, \(SE = 0.27, p < 0.05\)) and in the end-points of pain trajectories across participants (Headache: end-point intercept variance estimate = 6.44, \(SE = 0.78, p < 0.01\); Stomachache: end-point intercept variance estimate = 5.60, \(SE = 0.80, p < 0.001\); Backache: end-point intercept variance estimate = 4.14, \(SE = 0.57, p < 0.001\)).

Next, the linear component of the slope was considered. Analyses of the mean linear slopes indicated that, headache frequencies increased over time (linear mean estimate = 0.23, \(SE = 0.08, p < 0.01\)). This pattern of general increase was not seen for stomachache, but was seen for backache (Stomachache: linear mean estimate = 0.03, \(SE = 0.08, p > 0.05\); Backache linear mean estimate = 0.57, \(SE = 0.08, p < 0.001\)). The linear slope was associated with significant variance for all three recurrent pain trajectory models (Headache: slope variance estimate = 0.32, \(SE = 0.06, p < 0.001\); Stomachache: slope variance estimate = 0.32, \(SE = 0.07, p < 0.001\); Backache: slope variance estimate = 0.27, \(SE = 0.06, p < 0.001\)), indicating that there were significant differences in the linear trajectories of pain over time, across participants.
Analyses of the mean quadratic slopes indicated that there were general decelerations in pain frequencies over time for all three types of pain (Headache: quadratic mean estimate = -0.10, \( SE = 0.04, p < 0.01 \); Stomachache: quadratic mean estimate = -0.21, \( SE = 0.06, p < 0.001 \); Backache: quadratic mean estimate = -0.27, \( SE = 0.06, p < 0.001 \)). However, there were not significant individual differences in the quadratic slope component (Headache: quadratic slope variance estimate = 0.03, \( SE = 0.02, p > 0.05 \); Stomachache: quadratic slope variance estimate = 0.05, \( SE = 0.07, p > 0.05 \); Backache: quadratic slope variance estimate = 0.10, \( SE = 0.08, p > 0.05 \)). Thus, the quadratic term’s variance was fixed at 0 for all further trajectory model analyses.

With the quadratic term variance fixed, model fit statistics were computed to test how well the trajectories that were generated for each type of pain fit the data. Mplus version 3.13 does not produce goodness-of-fit indices when numerical integration procedures are applied to data that contain a combination of continuous and categorical/ordinal data. Thus, only overall model fit tests were obtained. The Likelihood Ratio Chi-square test was nonsignificant for headache, Likelihood Ratio \( \chi^2 (615) = 626.91, p > 0.05 \), indicating an excellent fit between the headache trajectory model and the data. In contrast, the Likelihood Ratio Chi-square tests were significant for the stomachache and backache trajectory models, Stomachache: Likelihood Ratio \( \chi^2 (615) = 676.74, p < 0.05 \); Backache: Likelihood Ratio \( \chi^2 (615) = 771.90, p < 0.001 \). Given the large sample sizes involved in the analyses, Chi-square/degrees-of-freedom ratios indicated good fit between the data and the headache, stomachache and backache models.

Results of analyses comparing the trajectories of the headache, stomachache and backache trajectories indicated significant associations between the start- and end-point
intercepts, as well as the slopes, of all of the three types of pain (see Table 5). In other words, there were strong similarities in the shapes of the headache, stomachache and backache trajectories.

*Psychosocial factors and recurrent pain intercepts.* Predictors of the intercepts (i.e., start- and end-points) of recurrent pain trajectories were examined. Psychosocial factors were entered into models separately, as gender-by-factor interactions, and simultaneously. The majority of gender-by-factor interaction effects were not significant and thus, only significant interactions were included in the final models where all psychosocial factors were included together. In the section below where results are presented in the text, only standardized parameter estimates and $p$ values will be reported to aid in readability. The standardized parameter estimates can be interpreted in the same way as Beta values are in the context of regression analyses and will be abbreviated as Beta ($\beta$). Estimates and standard errors can be provided upon request.

Across both the start- and end-point models where predictors were entered separately, gender, adolescent-report of anxiety/depression, and self-esteem were found to be associated with both the start- and end-points of headache trajectories (Gender-alone: Start-point intercept: $\beta = 0.21, p < 0.001$, End-point intercept: $\beta = 0.42, p < 0.001$; Adolescent-report of anxiety/depression-alone: Start-point intercept: $\beta = 0.36, p < 0.001$, End-point intercept: $\beta = 0.21, p < 0.01$; Self-esteem-alone: Start-point intercept: $\beta = -0.20, p < 0.001$, End-point intercept: $\beta = -0.13, p < 0.01$). Girls were more likely to have high frequencies of headache over the course of adolescence (e.g., at age 12-13 years and at age 18-19 years) than boys. Adolescents who reported higher anxiety/depression scores at age 10-11 years were found to be more likely to have higher frequencies of headache over the course of adolescence (e.g., at
adolescents who reported lower anxiety/depression scores at age 10-11 years. Also, adolescents who reported having lower self-esteem scores at age 10-11 years were found to be more likely to have higher frequencies of headache over the course of adolescence (e.g., at age 12-13 years and at age 18-19 years) than adolescents who reported higher self-esteem scores at age 10-11 years.

However, in simultaneous analyses, across both the start-point and end-point models only gender and adolescent-reports of anxiety/depression were found to be associated with both the start- and end-points of headache trajectories (Gender: Start-point intercept: $\beta = 0.13, p < 0.001$, End-point intercept: $\beta = 0.28, p < 0.001$; Adolescent-report of anxiety/depression: Start-point intercept: $\beta = 0.33, p < 0.001$, End-point intercept: $\beta = 0.17, p < 0.01$). Again, it was determined that girls were more likely to have high frequencies of headache over the course of adolescence (e.g., at age 12-13 years and at age 18-19 years) than boys. Also, adolescents who reported higher anxiety/depression scores at age 10-11 years were found to be more likely to have higher frequencies of headache over the course of adolescence (e.g., at age 12-13 years and at age 18-19 years) than adolescents who reported lower anxiety/depression scores at age 10-11 years. Thus, gender and adolescent-reported anxiety/depression were the strongest predictors of headache start- and end-point intercepts.

It also appeared that parental chronic headaches were important for adolescents who maintain high frequencies of headache over time. In the start-point models where predictors were entered separately, as well as in those where predictors were entered simultaneously, parent headache was found to be associated with the start-points of headache trajectories (Separate model: $\beta = 0.15, p < 0.05$; Simultaneous model: $\beta = 0.15, p < 0.05$). In the end-point models where predictors were entered separately and those where predictors were
entered simultaneously, the gender-by-parent headache interaction was found to be
associated with the end-points of headache trajectories (Separate model: $\beta = 0.10, p < 0.05$;
Simultaneous model: $\beta = 0.11, p < 0.05$). This interaction indicated that girls who had a
parent with recurrent headaches were most likely to have high frequencies of recurrent
headaches over the course of adolescence (e.g., at age 12-13 years and at age 18-19 years).
These findings together suggest that having a parent with chronic headaches also may be
important for adolescents who maintain high frequencies of headache over time, perhaps
most specifically for girls.

Slightly different results were found in terms of the predictors of stomachache start-
and end-point intercepts. Across both the start- and end-point models where predictors were
entered separately, gender, adolescent-report of anxiety/depression, and self-esteem were
found to be associated with both the start- and end-points of stomachache trajectories
(Gender-alone: Start-point intercept: $\beta = 0.25, p < 0.001$, End-point intercept: $\beta = 0.42, p <$
0.001; Adolescent-report of anxiety/depression-alone: Start-point intercept: $\beta = 0.32, p <$
0.001, End-point intercept: $\beta = 0.18, p < 0.01$; Self-esteem-alone: Start-point intercept: $\beta = -$
0.14, $p < 0.05$, End-point intercept: $\beta = -0.13, p < 0.01$). Again, it was determined that girls
were more likely to have high frequencies of stomachache over the course of adolescence
(e.g., at age 12-13 years and at age 18-19 years) than boys. Also, adolescents who reported
having high anxiety/depression at age 10-11 years were found to be more likely to have high
frequencies of stomachache over the course of adolescence (e.g., at age 12-13 years and at
age 18-19 years) than adolescents who reported lower anxiety/depression at age 10-11 years.
Lastly, adolescents who reported having low self-esteem at age 10-11 years were found to be
more likely to have high frequencies of stomachache over the course of adolescence (e.g., at
age 12-13 years and at age 18-19 years) than adolescents who reported higher self-esteem at age 10-11 years.

In the models where predictors were entered simultaneously, there were no psychosocial factors that were associated with both the start- and end-points of the stomachache trajectories. Thus, although gender, adolescent-reported anxiety/depression and self-esteem were shown to be predictive, they were not found to be strong, unique predictors. However, results from simultaneous models did suggest that anxiety/depression in general was important across the two time points. In the intercept start-point model with all the predictors included simultaneously, adolescent-reported anxiety/depression was found to be predictive of stomachache trajectory start-points ($\beta = 0.32, p < 0.001$). In the intercept end-point model with all the predictors included simultaneously, parent-reported anxiety/depression and interaction between gender and teacher-report of anxiety/depression were found to be predictive of stomachache trajectory end-points (Parent-reported anxiety/depression: $\beta = 0.18, p < 0.01$; Interaction between gender and teacher-report of anxiety/depression: $\beta = 0.49, p < 0.001$). Adolescents who reported having high anxiety/depression at age 10-11 years were more likely to have high frequencies of stomachache at age 12-13 years, and adolescents whose parents reported that they had high anxiety/depression at age 10-11 years were more likely to have high frequencies of stomachache at age 18-19 years. The same pattern was seen for girls whose teachers reported high anxiety/depression at age 10-11 years. Thus, it appears that, across reporters, anxiety/depression may be an important predictive factor for adolescents who maintain high frequencies of stomachache over time, especially for girls.
For backache, across both the start- and end-point backache models where predictors were entered separately, gender, adolescent-report of anxiety/depression, parent-report of adolescent anxiety/depression and self-esteem were all found to be associated with both the start- and end-points trajectories (Gender-alone: Start-point intercept: $\beta = 0.16, p < 0.01$, End-point intercept: $\beta = 0.22, p < 0.001$; Adolescent-report of anxiety/depression-alone: Start-point intercept: $\beta = 0.32, p < 0.001$, End-point intercept: $\beta = 0.16, p < 0.001$; Parent report of adolescent anxiety/depression-alone: Start-point intercept: $\beta = 0.18, p < 0.01$, End-point intercept: $\beta = 0.12, p < 0.05$; Self-esteem-alone: Start-point intercept: $\beta = -0.22, p < 0.001$, End-point intercept: $\beta = -0.16, p < 0.01$).

However, across both the start- and end-point models where predictors were entered simultaneously to determine which factors were unique predictors, only gender was found to be associated with both the start- and end-points of backache trajectories (Start-point intercept: $\beta = 0.10, p < 0.05$; End-point intercept: $\beta = 0.15, p < 0.001$). It was determined that girls were more likely to have high frequencies of backache over the course of adolescence (e.g., at age 12-13 years and at age 18-19 years) than boys. Thus, although adolescent-reported anxiety/depression and self-esteem were predictive in models on their own, gender was the only strong, unique predictor of high frequencies of backache over the course of adolescence.

**Psychosocial factors and recurrent pain slopes.** As was done when testing intercepts, psychosocial factors were tested separately, as gender-by-factor interactions, and simultaneously. In the following section, results regarding the predictors of recurrent pain trajectory slopes will be presented in the same way as they were in the previous section for predictors of recurrent pain trajectory intercepts.
For headache, the models where predictors were run separately and the model where all psychosocial factors were included simultaneously generated the same results. Only gender was found to be a unique significant predictor of headache trajectories (Gender-alone model: \( \beta = 0.38, p < 0.001 \); Simultaneous model: see Table 6). Specifically, adolescent girls were found to have greater increases in headache frequency over time (e.g., steeper trajectories) than adolescent boys.

Unlike headache, several psychosocial factors predicted the slope of stomachache trajectories. The stomachache models where predictors were run separately indicated that gender, parent-report of child anxiety/depression, and injury were significant predictors of stomachache trajectories (Gender-alone model: \( \beta = 0.27, p < 0.001 \); Parent-report of child anxiety/depression-alone: \( \beta = 0.20, p < 0.05 \); Injury-alone: \( \beta = -0.17, p < 0.05 \)). Girls and adolescents whose parents reported that they had higher anxiety/depression at age 10-11 years were found to have greater increases in stomachache frequency over time (e.g., steeper trajectories) than boys and adolescents whose parents reported that they had lower anxiety/depression at age 10-11 years. Adolescents whose parents reported that they had fewer injuries at age 10-11 years were also found to have greater increases in stomachache frequency over time (e.g., steeper trajectories) than adolescents whose parents reported that they had more injuries at age 10-11 years. The interaction between gender and teacher-report of child anxiety/depression was also a significant predictor of stomachache slope (\( \beta = 0.60, p < 0.01 \)). Girls whose teachers reported they had higher anxiety/depression at age 10-11 years were the most likely to have increases in stomachache frequency over time (e.g., steeper slopes).
When all the psychosocial predictors and the gender-by-teacher-report of child anxiety/depression interaction were included simultaneously, a slightly different set of factors emerged as unique, and therefore the strongest, predictors of stomachache slope (see Table 7). Injury, parent-report of adolescent anxiety/depression, and the interaction between gender and teacher-report of child anxiety/depression were found to be unique predictors of stomachache slopes. Adolescents with fewer injuries at age 10-11 years were more likely to have increasing frequency of stomachache over adolescence. Adolescents whose parents reported that they had higher anxiety/depression at age 10-11 years were more likely to have increasing frequencies of stomachache over time. Girls, whose teachers reported that they had high of anxiety/depression at age 10-11 years, were more likely to have increasing frequencies of stomachache (e.g., steeper trajectories). The results from the full model indicated that puberty and adolescent-report of anxiety/depression were also unique predictors of stomachache slope. Adolescents with lower pubertal development at age 10-11 years were more likely to have increasing frequency of stomachache over time. Interestingly, a different direction was seen in the adolescent-report anxiety/depression variable result than had been seen in the parent- and teacher-report anxiety/depression findings. The adolescent-report anxiety/depression variable result was in the negative direction, indicating that adolescents who reported less anxiety/depression were more likely to have increasing frequency of stomachache over time.

For backache, no psychosocial factors were found to significantly predict backache trajectories either separately or in simultaneous analyses. See Table 8 for results of simultaneous analyses.
Discussion

This study used a longitudinal population-level approach to determine the prevalence of recurrent pain and psychosocial predictors of recurrent pain trajectories across adolescence. A nationally representative cohort of 2,488 children from Statistic Canada’s NLSCY were studied at five time periods (Cycle 1: 10-11 years; Cycle 2: 12-13 years, Cycle 3: 14-15 years, Cycle 4: 16-17 years, and Cycle 5: 18-19 years). The following sections will explore themes across the findings of the present research pertaining to the prevalence of adolescence recurrent pain and the predictors of recurrent pain trajectories across adolescence. To close, the limitations, implications, and directions for future research will be discussed.

Recurrent Pain Prevalence

Several themes emerged in respect to the prevalence of adolescent recurrent pain and are briefly summarized here. Overall, high frequencies of recurrent pain were seen during adolescence. Prevalence rates were different for different types of recurrent pain (headache, stomachache, backache), and a subgroup of adolescents experiences multiple types of recurrent pain. Weekly recurrent pain rates increased over the course of adolescence only for headache and backache, but not stomachache. Finally, girls were seen to have higher rates of pain than boys. Each of these themes will be discussed in more detail below.

*High frequencies for all types of recurrent pain.* First, high frequencies of recurrent pain were seen across time and pain-type. Monthly headaches were reported by 28.6-38.5% of adolescents across the four time points, while weekly headaches were experienced by 26.2-31.8% of adolescents over time. Rates for monthly stomachaches were comparable (25.9-40.5%), while rates for weekly stomachache were slightly lower (13.5-22.2%).
Backaches were experienced by 21.2-33.3% of adolescents on a monthly basis and 17.6-25.8% on a weekly basis across adolescence. These prevalence rates were higher than those found by many other studies (Boey et al., 2000; Groholt et al., 2003; Larsson & Sund, 2005; Ramchandani et al., 2005), but were comparable to those found by others (Dooley et al., 2005; Gordon et al., 2004; Mustard et al., 2005).

There are several possible explanations for the generally high prevalence rates found in this research. The sample included in the present study was known to be representative at a national level. Other studies often used a school-based sampling technique that could have inadvertently excluded children who missed school due to recurrent pain during the time of data collection (Boey et al., 2000; Larsson & Sund, 2005). Many previous research studies also included a narrow age range that did not encompass any or all of the adolescent period when pain prevalence rates are known to surge (Boey et al., 2000; Ramchandani et al., 2005). Inconsistent questions about recurrent pain may also underlie the prevalence differences. In the NSLCY, adolescents were asked to report the frequency with which they experienced recurrent pain over the past 6 months. Previous studies used more specific diagnostic standards to determine whether recurrent pain was present (Boey et al., 2000; Boey & Goh, 2001a). More specific means of classifying recurrent pain could also have caused lower prevalence rates to be found. Rates in studies with more specific recurrent pain classification schemes may result in more accurate prevalence rates in relation to diagnostic pain conditions, for example migraine headaches, as opposed to recurrent headaches in general. Thus, these types of recurrent pain classification systems may be preferable in research determining the prevalence of specific types of diagnostic pain conditions. Differences in reporters across studies also may explain differences in prevalence rates across studies. For
example, in the studies by Groholt and colleagues (2003) and Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen and colleagues (2000), the parent and/or child completed questionnaires. Because pain is a subjective experience, self-report is generally considered an good means to evaluate pain experiences (McGrath & Gillespie, 2001). It is possible that in studies where parents reported on behalf of adolescents, recurrent pain prevalence rates would be lower than those in studies where adolescent-report was the means of determining prevalence.

However, prevalence rates in this research were comparable to those found in other studies that also used Canadian survey data (Dooley et al., 2005; Gordon et al., 2004; Mustard et al., 2005), most specifically to the work by Gordon and colleagues investigating the prevalence of headache in the first half of adolescence that also used the NLSCY (Dooley et al., 2005; Gordon et al., 2004). The present study extended previous research by Gordon and colleagues (Dooley et al., 2005; Gordon et al., 2004) by considering the prevalence of stomachache, backache, as well as headache, and by looking at prevalence rates across all of the adolescent period, not just the first half.

_Differences in headache, stomachache and backache prevalence rates._ A second theme seen pertained to the prevalence rates of headache, stomachache, and backache across adolescence. Different prevalence rates were seen for the three types of recurrent pain. Overall, weekly headache was the most common type of recurrent pain reported across adolescence and weekly stomachache was the least common type of recurrent pain. The headache finding paralleled work done in previous studies that considered the prevalence of multiple types of recurrent pain in adolescents (Egger et al., 1999; Ghandour et al., 2004; Groholt et al., 2003). There are many reasons why headaches may be the most prevalent of
the three types of pain. Perhaps headaches have many potential causes (e.g., genetic conditions, eye strain, stress, etc.) making them easier to have and this is why they are more commonly experienced. The finding that stomachache was the least common type of weekly recurrent pain was supported by some previous research studies (Ghandour et al., 2004), but not others (Groholt et al., 2003). Work by Groholt and colleagues (2003) included a sample of 7- to 17-year-old children, and it is possible that had an older sample been considered, overall rates for stomachache would have been lower. An alternate explanation could be that stomachaches have a narrow range of potential causes and are thus less likely to present. It is unfortunate that the questions in the NLSCY about recurrent pain did not include information about the qualitative nature of the headaches, stomachaches or backaches, as these details would help to tease apart whether there, in fact, were more subtypes of headache compared to stomachache (e.g., migraine headaches, tension headaches, etc. versus only cramping stomachaches) and, therefore, perhaps more headache causes.

Rates across adolescence. In keeping with predictions and the findings of previous research (Perquin, Hazebroek-Kampschreur, Hunfeld, & Bohnen et al., 2000), the rates of weekly headache and backache were higher at the end of adolescence than they were at the onset. However, stomachaches showed the opposite pattern. Boey and colleagues (2000) found that no age-associated effects existed in terms of the prevalence of RAP. One possible explanation for the headache and backache results would be that factors that are involved with the development of these types of pain become stronger influences over the course of adolescence. Anxiety and depression may be two of these types of factors. It is unclear why rates of stomachache were not found to increase over the course of adolescence. Perhaps factors, such as parent pain behaviour modeling, are especially important for stomachache. If
this is the case, decreases in stomachache prevalence over the course of adolescence may be due to decreases in the strength of parents as models as adolescents get older.

*Multiple pains.* Another clear theme that emerged from the prevalence results was that there was a subgroup of adolescents who experienced more than one type of recurrent pain on a weekly basis. The prevalence of adolescents experiencing two types of recurrent pain on a weekly basis ranged from 5.7% (stomachache and backache at 16-17 years) to 14.7% (headache and stomachache at 14-15 years). Another group of adolescents experienced all types of recurrent pain on a weekly basis (ranging from 3.6-8.6% across cycles). These findings were consistent with previous research studies that also found subgroups of adolescents who reported experiencing more than one type of recurrent pain regularly (Ghandour et al., 2004) or that adolescents experiencing one type of recurrent pain were more likely to experience other types of recurrent pain (Boey & Goh, 2001a; El-Metwally et al., 2006; Ramchandani et al., 2005). Research is needed to help us better understand what causes the development of multiple types of recurrent pain in an individual adolescent. One possibility is that these pains develop independently. Another possibility is that one type of pain develops first and then fuels the development of a second type of pain, for example an adolescent with recurrent stomachaches may restrict their activities and then develop recurrent backaches as a result. A final possibility is that the multiple types of recurrent pain stem from a common cause, perhaps biological, or as the physiological manifestation of stress or psychological factors, such as anxiety.

In terms of pairs of recurrent pains, headache and stomachache was the most commonly experienced pair of weekly recurrent pains during the first half of adolescence, experienced by 11.8% of adolescents at 12-13 years and 14.7% at 14-15 years. During the
later half of adolescence, headache and backache was the most commonly experienced pair of weekly recurrent pains, reported by 10.2% of adolescents at 16-17 years, and 10.5% at 18-19 years. Stomachache and backache was the least common pair of weekly recurrent pains throughout adolescence. Results from the present study on which pairs of pains were the most and least common generally matched results found by Groholt and colleagues (2003). Perquin, Hazebroek-Kampschreur, Hunfeld, Bohnen and colleagues (2000) also found that headache and stomachache was the most common pair of pains. These findings are also in line with the general prevalence results described earlier that showed headaches, on their own, to be the most prevalent type of recurrent pain across adolescence, followed by stomachaches and backaches. It is unclear, though, why the combination of headaches and stomachaches would be more common during early-mid adolescence, while the pairing of headaches and backaches would be more common during mid-late adolescence. It is possible that stress is a common cause of the multiple pains experienced by these adolescents and that it is more normative/acceptable for young teenagers to articulate the physical symptoms they feel when they are stressed as headaches and stomachaches, while for older adolescents, headaches and backaches are more socially appropriate.

**Gender differences.** Another strong theme in the prevalence results related to gender. The importance of gender in the prevalence of recurrent pain was highlighted when prevalence rates for girls and boys were considered independently. For all types of pain and at all cycles/ages, there were differences between girls’ and boys’ patterns of responses to the recurrent pain items. As predicted, girls reported higher frequencies of recurrent pain than boys across adolescence. This was not surprising given previous research on recurrent pain prevalence and gender differences in pain. Girls have been noted to have higher rates of
headache (Larsson & Sund, 2005), backache (Hakala et al., 2002) and stomachache (Groholt et al., 2003). The mechanisms that are responsible for high levels of recurrent pain in adolescent girls are not well known. Gender differences in catecholaminergic and serotonergic pathways in the brain caused by the effects of ovarian hormones may relate to gender differences in pain processing (Unruh & Campbell, 1999). Further, hormonal and anatomical processes specific to puberty may make girls more vulnerable to developing recurrent migraines, although the specific mechanisms behind these processes are not well known (Unruh & Campbell, 1999). Menstruation is often accompanied by cramping stomachaches and back pain in some women. Further, research on pain expression and assessment has shown that young girls tend to express pain more frequently (Fearon, McGrath, & Achat, 1996), as well as rate pain as being more intense than boys (Chambers, Giesbrecht, Craig, Bennett, & Huntsman, 1999). Internalizing disorders are more common in adolescent girls than boys (Crick & Zahn-Waxler, 2003). Perhaps girls who are anxious or depressed are more likely to develop recurrent pain as a physical manifestation of their worry or sadness. Pine, Cohen, and Brook (1996) suggest that links between headache and depression may be due to serotonergic dysfunction in the central nervous system (CNS), and point to evidence that depression and headaches are treated with serotonin regulating medications. Egger and colleagues (Egger et al., 1998; Egger et al., 1999) have postulated that connections between gender differences in recurrent headache and internalizing disorders may be due to this serotonergic dysfunction in the CNS. It is likely that biological, psychological and social-reporting processes are all at play in causing gender differences in adolescent recurrent pain prevalence.
Psychosocial Factors and Recurrent Pain Trajectories

The psychosocial factors tested for their ability to predict recurrent pain trajectories came from a model that included underlying vulnerability factors (i.e., gender, pubertal status and the presence of parental chronic pain), precipitating stimuli (i.e., injury, illness/hospitalization and stressful life events), and psychological factors (i.e., anxiety/depression and self-esteem). Factors were tested for their ability to predict the stability in recurrent pain (i.e., trajectory intercepts), as well as change in levels of pain frequency over time (i.e., trajectory slopes).

Several themes emerged from the results on psychosocial factors and recurrent pain trajectories. First, several psychosocial factors were predictive across types of pain, intercepts and slopes, specifically gender and anxiety/depression. However, a second theme that emerged was that differences existed across pain types. For example, parent headache was associated with only headache intercepts, while pubertal status and injury predicted only stomachache slopes. A third theme was that differences also pertained to intercepts versus slopes. Self-esteem was predictive of start- and end- point intercepts for all types of recurrent pain, but was not predictive of slopes. A final theme was that many psychosocial factors were not predictive of intercepts and/or slopes, most notably illness/hospitalization, and stressful life events.

Psychosocial factors important to all types of recurrent pain. One theme apparent across all the results on psychosocial factors and recurrent pain trajectories was that gender and anxiety/depression were important predictors of recurrent headache, stomachache and backache trajectories. Gender was found to predict the start- and end-point intercepts of headaches and backaches in simultaneous models that included all psychosocial factors.
together. Gender predicted stomachache trajectory start- and end-points in the models where it was run alone. In all cases, girls exhibited more stable, high frequencies of recurrent pain over time compared to boys. In relation to recurrent pain trajectory slopes, gender was predictive of headache and backache slopes in simultaneous models that included all psychosocial factors together. Gender was also predictive of stomachache trajectory slopes, but only when tested in the model on its own. In all cases, girls exhibited steeper increases in pain over time compared to boys. To summarize these findings, girls were found to have higher frequencies of recurrent pain at the start and end of adolescence, as well as have steeper, positive trajectory slopes.

In combination with the cross-sectional prevalence findings of gender differences, these patterns suggest that girls are a truly vulnerable subgroup in terms of developing and maintaining recurrent pains. Different factors may explain why girls were seen to have high frequencies of recurrent pain across adolescence versus why girls were seen to have increasing frequencies of pain over the course of adolescence. Biological vulnerabilities could make some girls more prone to have high frequencies of recurrent pain across adolescence. These girls could be ones that are more likely to have pain with menstruation. Also discussed above, gender differences in recurrent headache and internalizing disorders may be due to serotonergic dysfunction in the CNS (Egger et al., 1998; Egger et al., 1999; Pine et al., 1996). Other psychosocial factors may explain why girls have increasing levels of recurrent pain over the course of adolescence. Some girls may be particularly influenced by increasing exposure to gender-based social norms in relation to pain, and these girls may feel more and more comfortable reporting pain over the course of adolescence. Alternatively, some girls could have had trouble managing or coping with recurrent pain when it occurred.
early in adolescence and this made recurrent pain more and more likely to reoccur in the future. These girls may have experienced reinforcement when they experienced recurrent pain, such as extra attention from parents or peers, or academic consolation, and this made them more and more likely to experience recurrent pain in the future.

Alongside gender, anxiety/depression also appeared to be an important predictor of recurrent headache, stomachache and backache trajectory intercepts and slopes. Anxiety/depression predicted headache, stomachache and backache start- and end-point intercepts. In models where factors were run separately, higher frequencies of adolescent-reported anxiety/depression were associated with higher start- and end-point intercepts for headache, stomachache and backache. Higher parent-reports of adolescent anxiety/depression also predicted higher backache start- and end-point intercepts in separate models. For headache only, results for adolescent-reported anxiety/depression remained significant in models where all psychosocial factors were run simultaneously. With respect to trajectory slopes, adolescents whose parents reported they had high anxiety/depression were more likely to have increasing frequencies of stomachaches over time. Similarly, girls whose teachers reported that they had high anxiety/depression were also found to be more likely to go on to develop stomachaches. In contrast, adolescents who reported lower anxiety/depression at 10-11 years were also more likely to go on to develop recurrent stomachaches.

These intercept and slope findings suggest that anxiety/depression has predictive influences across all types of recurrent pain in relation to start- and end-point intercepts, but more specific predictive effects in relation to stomachache slopes. Results showing high anxiety/depression to be predictive of high frequencies of pain are supported by previous
research that showed a strong association between recurrent pain and psychological factors, such as anxiety and depression (Dooley et al., 2005; Egger et al., 1998; Egger et al., 1999; Gordon et al., 2004; Larsson & Sund, 2005). There are many possible reasons for the connection between recurrent pain and anxiety/depression. One reason could relate to parent mental health. Research on pain in families has shown that children whose parents are depressed are more likely than children whose parents are not depressed to have depression themselves and depressed children of depressed parents are more likely to have headaches (Kramer et al., 1998). It is also possible that adolescents with anxiety/depression develop recurrent pain as a physical symptom of their psychological worry and sadness, or that they are more sensitive to their body and notice pain more than adolescents who are not anxious or depressed. It is interesting to think about why anxiety/depression was predictive of trajectory slopes only for stomachache and not headache or backache. Perhaps adolescents with anxiety/depression feel least confident that they can cope with and effectively manage recurrent stomachaches when they occur and this makes stomachaches get worse and more frequent over the course of adolescence. Further, children with chronic pain are known to have difficulties with school, peer and family functioning (Palermo, 2000). Problems at school, home and with friends are likely to make adolescents feel even more anxious and sad. Once developed, recurrent stomachaches and anxiety/depression may interact reciprocally to fuel each other to get worse over the course of adolescence.

Further, since adolescent-, parent- and teacher-reports of anxiety/depression were positively correlated with each other, it is important to think about why adolescents who reported lower anxiety/depression at age 10-11 years were more likely to develop recurrent stomachaches, but higher adolescent anxiety/depression at this age predicted increasing
stomachaches when parent- and teacher-reports were considered. Perhaps a vulnerable subgroup of young adolescents exist who reported low levels of anxiety/depression did not have a great need to develop and use adversity coping skills during childhood and, as a result, had difficulty managing stomachaches when they occurred later in adolescence. Alternatively, these adolescents may have been more comfortable reporting physical symptoms as opposed to psychological ones. Regardless, it will be important to replicate these findings and to consider young adolescents able to provide valid representations of their emotional and physical states.

Specificity across types of recurrent pain. Despite gender and anxiety/depression being common predictors of headache, stomachache and backache trajectories, a second theme that emerged from study findings was that there were instances of specificity, whereby certain psychosocial factors were associated with only one type of recurrent pain.

Having a parent with headaches was found to be predictive of high frequencies of adolescent headaches at 12-13 years. At 18-19 years, parent headaches were predictive of high frequencies of headaches for adolescent girls. This was the only time the presence of parent chronic pain was found to be associated with adolescent recurrent pain trajectories. These findings may suggest a shared genetic vulnerability for headaches and/or the effects of parental pain modeling. It is interesting that the present study found an association between parent and adolescent recurrent pain in terms of headache, but not for stomachache or backache. It is possible that the headache-specific result seen indicates that there is a stronger genetic connection between parents and children for headache or that pain modeling is more salient for headaches than for stomachaches or backaches. However, research done in urban Malaysia by Boey and Goh (2001a) showed that early-adolescents were more likely to have
RAP if their parent experienced abdominal pain. Perhaps stronger predictive associations between parent chronic pain and all types of adolescent recurrent pain would have been seen if recurrent pains in the NLSCY had been operationalized in a more specific way, as was done in the RAP research by Boey and Goh (2001a).

For stomachache, adolescents with lower pubertal development at age 10-11 years were more likely to develop higher frequencies of recurrent stomachaches over the course of adolescence. In contrast, puberty did not predict headache or backache slopes. A social explanation may underlie these findings. For young adolescents, the stress of lagging behind their peers in terms of pubertal development may manifest as recurrent stomachaches. This stress may be related to headaches and backaches as well, but adolescents may have a harder time coping with and managing stomachaches when they occur. The combination of continued stress and difficulty managing recurrent stomachaches over time might cause these adolescents to experience increasing frequencies of stomachache.

Additionally in regards to stomachache, adolescents with fewer injuries at the first assessment were more likely to develop higher frequencies of recurrent stomachaches over time. In contrast, injuries did not predict headache or backache. This finding may also be related to the anxiety/depression findings described above. Perhaps adolescents who are more anxious tend to avoid situations that may cause danger or injury. These children would have fewer injuries, but also may be more likely to develop physical symptoms, in the form of stomachaches, as a result of their high levels of worry. It is interesting that lower pubertal development and injury at age 10-11 years would relate to stomachache trajectories, but not headache or backache trajectories. Stress was proposed to explain the link between puberty, and stomachache and perhaps it again plays a role in explaining the link between injury and
stomachache. Anxious adolescents who avoid danger and are therefore less likely to be injured may develop headaches and backaches along with stomachaches as physical manifestations of their worry. However, stomachaches may be more difficult for adolescents to cope with or treat and this may be what makes them get worse and more frequent over time.

Specificity across start- and end-point intercepts versus slopes. In addition, there were some interesting differences in the factors that predicted intercepts versus slopes. Low adolescent self-esteem at age 10-11 years predicted high start- and end-point intercepts for all types of recurrent pain in models where it was considered separately. However, self-esteem was not predictive of increasing slopes over time for any of the types of recurrent pain. These results suggest that self-esteem in early adolescence is related to the development of high frequencies of pain that are maintained across adolescence. These findings support previous work suggesting that self-esteem/sense of mastery is a key variable in relation to child health (Chen et al., 2002) and to the development of adult chronic pain (Turk, 2002). It is likely that adolescents with low self-esteem are likely to feel less able to manage and cope with recurrent pain when it occurs and this causes it to be experienced at consistently high levels over time. Overall, the fact that certain factors related to intercepts but not slopes, or vice versa, make it important to ask why a psychosocial factor would be predictive of stable, high frequencies of recurrent pain across adolescence, but not of increasing frequencies of pain over time, or vice versa. Factors predictive of high frequencies of recurrent pain at both the beginning and end of adolescence may have an immediate impact on recurrent pain and may be relatively common in prevalence throughout adolescence. Perhaps factors that are associated with recurrent pain slopes are ones whose influence on recurrent pain frequency
only unfolds slowly over time. Alternatively, these factors may become more and more prevalent over the course of adolescence and this is why they are associated with higher frequencies of pain over time.

Taken together, findings showing both similarities and differences in the results pertaining to psychosocial factors and individual types of pain, as well as for trajectory intercepts versus slopes have important implications. Despite strong relationships between the components of the headache, stomachache and backache trajectories, as well as common predictors, such as gender and anxiety/depression, different types of recurrent pain do not seem to develop from totally identical psychosocial processes. Further, there seems to be a need to consider adolescents who have high frequency pain throughout the course of adolescence somewhat distinctly from adolescents who are developing increasing frequencies of recurrent pain over time. Different psychosocial processes may be important to explain the types of recurrent pain experienced in these two groups.

*Psychosocial factors not found to predict recurrent pain trajectories.* A final theme apparent in the results on psychosocial factors and recurrent pain trajectories was that many psychosocial factors thought to be important to recurrent pain were not seen to be predictive when longitudinal analyses were used. Across intercept analyses, pubertal status, injury, illness/hospitalization, and stressful life events were not found to be predictive of high frequencies of recurrent pain over time. A striking example was seen in the results for backache slopes, where no psychosocial factors were found to be predictive. Across slope analyses for headache and stomachache, parent chronic pain, illness/hospitalization, stressful life events, and self-esteem were not seen to be predictive of either type of recurrent pain slopes.
There are many possible explanations for these findings. The predictors tested in the present model were taken from reports made at Cycle 1, when adolescents were 10-11 years old. It is possible that predictors assessed concurrent to the start of the recurrent pain trajectories would be predictive. Alternatively, it is possible that recurrent pain trajectories were set early in childhood, prior to the ages at which psychosocial factors were measured in this study. One such example might be neonatal experiences with pain. Infants in the NICU are subjected to multiple painful diagnostic procedures (Taddio, 1999). Prolonged hospitalization in the neonatal period, in comparison to no hospitalization, has been shown to relate to higher levels of parent-rated pain sensitivity later in infancy (Grunau, Whitfield, & Petrie, 1994), higher rates of parent-reported somatic complaints in early childhood (Grunau, Whitfield, Petrie, & Fryer, 1994), and higher ratings of pain intensity in response to hypothetical vignettes in middle childhood (Grunau, Whitfield, & Petrie, 1998). It is also possible that other types of predictors, also untapped in the present study, are responsible for setting adolescent recurrent pain trajectories, such as temperament (Unruh & Campbell, 1999), other types of psychopathology, such as conduct disorder and attention deficit hyperactivity disorder (Egger et al., 1998; Egger et al., 1999), health behaviours (Larsson & Sund, 2005; Lewin & Dahl, 1999; Palermo, 2000; Walters & Williamson, 1999), family functioning (Aromaa, Sillanpaa, Rautava & Helenius, 2000; Chambers, 2003; Wood et al., 1989), peer social activities (Meijer, Sinnema, Bijstra, Mellenbergh, & Wolters, 2000), and school success/attendance (Dooley et al., 2005; Flato, Aasland, Vinje & Forre, 1998; Gordon et al., 2004; Larsson & Sund, 2005; Newacheck & Taylor, 1992), and these factors may play a role in the development of recurrent pain over the course of adolescence. In relation to parent chronic pain, the many of the painful chronic illness items in the NLSCY were very in
relation to types of pain that are often due to known causes or specific diagnoses, for example "migraines" and "intestinal ulcers". It is possible that parent chronic pain may be found to be predictive of child recurrent pain in future research where parent chronic pain items pertain to more general types of pain, for example "headache" and "stomachache".

Finally, previous research on psychosocial factors and recurrent pain has used cross-sectional designs. It is possible that the psychosocial factors that emerge as being associated with recurrent pain may be different than the types of factors that emerge in longitudinal designs as being predictive of recurrent pain. It is possible that many psychosocial factors that have been found to be associated with recurrent pain in cross-sectional research are actually caused by recurrent pain. For example, academic difficulties are common in children and adolescents with recurrent pain (Palermo, 2000). However, it seems likely that academic difficulties may first arise when pain interferes with school for children who have recurrent pain. Longitudinal designs may illustrate reciprocal relationships between psychosocial factors and recurrent pain, for example anxiety/depression was found in the present study to predict increasing stomachache slopes over time. It is also likely that recurrent pain causes anxiety and depression over time.

The Psychosocial Model for the Development of Adolescent Recurrent Pain

The findings of the present study have important implications for the proposed psychosocial model for adolescent recurrent pain. First, prevalence results confirmed that adolescence is a time when frequencies of recurrent pain increase. The results of the present study provided empirical support for gender and psychological factors as being important components of the psychosocial model of adolescent recurrent pain development. Findings supported pubertal status, parent headache, injury, and self-esteem also remaining in the
model of adolescent recurrent pain development, as these factors were found to predict specific types of recurrent pain (e.g., headache or stomachache) and/or specific types of trajectories (e.g., high, stable intercepts or increasing slopes). Generally, more support was found for the underlying vulnerability factors and psychological factors as being components in the adolescent recurrent pain development model than for the precipitating stimuli factors. These results showing commonalities, as well as differences across pain-type and trajectory-types supported having one general adolescent recurrent pain development model, but also emphasized the need to test the model in terms of specific types of recurrent pain and in terms of specific types of trajectories. See Figure 9 for a graphical depiction of the implications of the results of the present study on the psychosocial model of adolescent recurrent pain development. Ideas for future research on the model are discussed in detail in the sections below.

Strengths, Limitations and Future Research

Conducting research with population-level survey data offers opportunities not usually available in traditional research designs. Large samples and survey weights allow results to be generalizable at a national level. Longitudinal designs allow developmental processes to be examined over time. Large financial resources allow for many different types of variables and reporters to be included during the data collection process. All of these benefits were taken advantage of in the present study to examine recurrent pain across adolescence. Future research should continue to take advantage of the design advantages of longitudinal population-survey data in studying recurrent pain trajectories.

A specific strength of longitudinal population-level surveys is that they often include multiple cohorts that are sampled over time. This was the case in the NLSCY. For the present
study, one such cohort was selected and studied over the course of adolescence and it is important to acknowledge that cohort effects may be partially responsible for the findings of this research. Hakala and colleagues (2002) found that in their population-level study of back, neck and shoulder pain in Finnish adolescents that pain prevalence increased in the 1990s and was continuing to rise. These results suggest that the timing of sampling in national survey data may be important to consider and highlight the need to consider multiple cohorts in research on recurrent pain. Ideally, multiple cohorts will be included in future studies so that the effects of one cohort of adolescents can be taken into account and separated from results that apply across cohorts. In the short term, a replication study of the present research should be done using another cohort within the NLSCY.

A major strength of the present study was that headache, stomachache and backache were considered independently. Results found that, although there were strong associations between the developmental trajectories of the three types of pain, specific psychosocial factors were associated with different types of recurrent pain, such as injury and pubertal development in relation to recurrent stomachache trajectories. Future research should continue to study multiple types of recurrent pain at once, and also include other types, such as limb pain.

Another strength of the present study was that the psychosocial factors predictive of stable, high frequencies of pain at the beginning and end of adolescence (i.e., trajectory start- and end-point intercepts), as well as increasing frequencies of recurrent pain over time (i.e., trajectory slopes) were considered independently. Specific psychosocial factors in relation to specific pain-type trajectories should be explored further, for example parent headache in relation to adolescent headache start- and end-point intercepts, puberty and injury in relation
to adolescent stomachache slopes, as well as gender and adolescent-reports of anxiety/depression in relation to backache start- and end-point intercepts. For example, in the case of parent headache and stable, high frequencies of recurrent headache across adolescence, future research could study whether or not parent modeling of pain behaviour or parent beliefs about pain play a role in adolescent recurrent headaches.

A further strength of the NLSCY is that it includes data from multiple reporters. This research was able to include adolescent-, parent-, and teacher-report data, and differences were seen among the adolescent-, parent- and teacher-reports of anxiety/depression in relation to recurrent pain outcomes. Differences across reports can be seen as an indication that each reporter provides a unique perspective of the construct being assessed (Holmbeck et al., 2002). For example, adolescents may provide unique accounts of their anxiety/depression. Parents may have a strong sense of adolescent's anxiety/depression as it is expressed within the family. Teachers have a unique perspective of outward signs of anxiety/depression within the context of school and in comparison to other peers. The fact that differences were seen in how adolescent-, parent- and teacher-reports of anxiety/depression related to recurrent pain trajectories reinforced the notion that the three different reporters provided unique perspectives on adolescent anxiety/depression.

Unfortunately, for most of the variables included in this research, only single-reporter data were available. It is possible that adolescent-reports of psychosocial factors such as stressful life events or parent-reports of adolescent self-esteem would have added unique perspectives on these constructs that would have been predictive of recurrent pain. Future research on the psychosocial predictors of recurrent pain should include assessments from multiple reporters as often as possible.
Alongside the strengths of population-level survey data, using survey data also has limitations that are important to acknowledge. Although a wide range of variables are included, researchers are not able to choose measures a priori. In the present study, for example, although there were questions on three types of recurrent pain, questions were related only to the frequency of headache, stomachache and backache. Ideally, information about pain intensity, duration, quality, and impairment would have also been included. Questions about recurrent pain also required adolescents to think back over the past 6 months in order to report pain frequency. A more recent recall time frame may make reports of recurrent pain frequency more accurate. Information about recurrent pain intensity, duration, quality and impairment obtained from a recent recall window should be included in future research on recurrent pain development.

Although the longitudinal nature of the survey is a key design strength, the 2-year gap between NLSCY cycles of data collection and the fact that, in the present study, psychosocial factors were sampled when adolescents were 10-11 years could be considered a weakness. It is possible that important patterns in levels of recurrent pain occur in windows narrower than 2 years. In the present study, psychosocial factor data was drawn from Cycle 1, when children were 10-11 years. This was done because it allowed potential predictors to be temporally precedent to the recurrent pain trajectories, making inferences about directionality clearer. However, it is possible that 2 years was too distal from the recurrent pain trajectories for factors to have an impact. It is also possible that age 10-11 years was too proximal to see the impact of psychosocial factors on pain trajectories. Further, different predictors may be relevant at different time points across adolescence. For example, certain predictors, such as family factors, may be most important during early childhood, whereas other predictors, such
as peer factors, may be most important during adolescence. If the survey sampled adolescents more frequently there would have been more options and opportunities to determine the time periods in which specific psychosocial factors were influential. Thus, future population-level research should employ narrower sampling windows in order to better capture recurrent pain development as it unfolds across childhood and adolescence and predictor data should be drawn from time periods that range from early childhood, right up to the time when recurrent pain trajectories start to be tracked.

Limitations related to survey items also pertained to the psychosocial factors included in the present study. In Cycle 1 of the NLSCY (cohort age = 10-11 years), there was one scale that assessed adolescents’ experiences with both anxiety and depression. In later cycles, a modified version of the Centre for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) was included to assess adolescent depression independently. It would have been ideal if anxiety and depression could have been assessed separately in Cycle 1 (cohort age = 10-11 years) as well. Further, many of the psychosocial factor variables required retrospective recall over the past year (e.g., injury, illness/hospitalization). As was the case for the recurrent pain questions, it is possible that these items would have been more accurate had the recall window been shorter. Thus, even though the results of the present study did not find several psychosocial factors, such as illness/hospitalization and stressful life events, to be predictive of recurrent pain trajectories, this does not mean that they should be omitted in future research. In general, more detailed, in-depth measures of parent chronic pain, pubertal development, illness/hospitalization, and stressful life events could have increased the validity of the constructs and perhaps improved their ability to predict recurrent pain trajectories, and should be included in future research.
Future research using the NLSCY and adolescent recurrent pain should also explore other types of psychosocial variables that were not the focus of the present study. As was described above, previous research has found associations between recurrent pain and a range of other child, family, peer and school psychosocial factors. It will be interesting to see whether these types of factors are more strongly related to recurrent pain trajectories. In addition to family, peer and school factors, neighbourhood and socioeconomic variables would also be interesting to investigate, as these psychosocial factors have been shown to relate to other negative child developmental and health outcomes (Curtis et al., 2004; Leventhal & Brooks-Gunn, 2000).

It will also be important for future research to explicitly study the role culture and ethnicity play in the prevalence and development of adolescent recurrent pain. Culture is postulated to play an important role in people's subjective understanding, means of expressing and patterns of reporting pain (Craig 1980, 2002; Craig et al., 1996; Craig & Pillai Riddell, 2003; McGrath & Gillespie, 2001; McGrath & McAlpine, 1993). Despite placing theoretical importance on the role of culture in pain, there is little research exploring how culture influences children's experiences of pain (Craig & Pillai Riddell, 2003). One study by Litcher and colleagues (2001) found that children in the southern United States reported more somatic symptoms than children from the Ukraine, many of whom had experienced the Chernobyl disaster, even though the mothers of the Ukrainian children reported more symptoms than American mothers. This study highlights the need for future research on the relationship of culture and pain to take a fine-grained approach. Canada is a diverse country comprised of many geographic regions and ethnicities, and these may shape culture as it pertains to pediatric pain. In population-level studies done in countries like Canada, such as
the NLSCY, different ethnic and cultural groups are represented within the cohorts sampled. However, these subgroups are small. Future research should take a cross-cultural approach, comparing prevalence rates across countries, as well as within. In studies that look at ethnic groups within a country, small groups may need to be oversampled so that even though their sample size is not representative at a population-level, comparisons can be made with larger ethnic groups. Variables such as acculturation should be considered in future research as acculturation may play an important role in mediating cultural beliefs and reporting biases regarding recurrent pain and psychosocial factors, such as anxiety and depression. In addition, measuring acculturation is important for acknowledging variability in recurrent pain within ethnic groups.

A more general limitation of working with survey data includes the fact that survey data does not facilitate the study of biological mechanisms. However, it is very likely that biological factors, such as hormonal changes at puberty (Unruh & Campbell, 1999), play an important role in causing recurrent pain, as well as help explain how psychosocial factors are related to the development of recurrent pain, such as gender. Different types of research designs will enable researchers to consider these other types of biological and psychosocial factors. Adolescents participating in smaller longitudinal studies could use daily diary methods to record pain experiences, as well as to report on psychosocial predictors, such as stressful life events, general health, mood, and emotions without relying on retrospective recall measures. Such research would allow the day-to-day relationships between psychosocial factors and recurrent pain to be studied. Biological mechanisms could be studied by collecting biological markers in blood and saliva, such as puberty-related hormones. In-depth interviews with adolescents and parents could allow researchers to gather
information about temperament, personality, parental beliefs and behaviours regarding pain, pain in siblings, information regarding prolonged hospitalization in the neonatal period and other types of psychopathology.

Implications and Future Research

Treatment and prevention. The present study generated findings that have important implications for the field of pediatric pain. Results from prevalence analyses showed that recurrent pain is very common throughout adolescence. Demonstrating accurate prevalence data is an important precursor to advocating for adolescent recurrent pain prevention and treatment initiatives. The fact that girls had higher frequencies of all types of pain, at all time points suggested that they are an important vulnerable subgroup to study in future research aimed at preventing and treating recurrent pain. Prevalence results also suggested that adolescents who have two or three different types of recurrent pain on a weekly basis may be another vulnerable subgroup to target in future prevention and treatment research.

Analyses looking at the psychosocial factors predictive of recurrent pain trajectories also offer several suggestions for potential elements to include in prevention and treatment research. Gender predicted recurrent pain intercepts and slopes across adolescence. It is not yet clear what it is about being a female that makes high frequencies of recurrent pain more likely or makes recurrent pain likely to increase over the course of adolescence. Research on treatment and prevention will need to try and isolate the biological, sociocultural and emotional factors that girls as a group experience and that make girls more vulnerable to recurrent pain. Overall, anxiety/depression and self-esteem at the onset of adolescence (ages 10-11 years) were other psychosocial factors shown to be predictive of recurrent pain frequencies across adolescence. Future research on recurrent pain prevention and treatment
should include adolescent anxiety, depression and self-esteem as important target variables, using detailed measures and multiple reporters.

**Conceptual models.** Alongside vulnerable subgroups and target variables to study in research on recurrent pain prevention and treatment, the results of the present study have important implications for research aimed at refining the psychosocial model of adolescent recurrent pain development. There are several ways that future research could attempt to refine the model. The present study focused on the adolescent time period. Future research should continue to consider recurrent pain development in a temporally specific way. Models may be refined to capture psychosocial factors involved with recurrent pain during early and middle childhood, as well as the transition from adolescence to adulthood.

In the process of interpreting the results of the present study, it also became clear that refinements are needed to the present model in relation to the mechanisms that link psychosocial variables and pain. Few examples exist in the literature to suggest the mechanisms by which psychosocial factors affect pain. However, there are a few examples of models in the literature that do incorporate a more fine-grained approach, these include Walker's (1999) model for the development of RAP in childhood and Turk's (2002) injury-based model for the development of adult chronic pain. Walker’s (1999) model includes social learning processes, such as reinforcement, to explain several potential outcomes for children with RAP. The results of the present did not directly test the role of social learning in the development of adolescent recurrent pain. However, support was seen for parent chronic pain in relation to high, stable levels of adolescent headache. In order to tease apart the role that biological and social learning mechanisms may play between parent chronic pain and adolescent recurrent pain development, future research would need to take a fine-
grained approach to focus on these specific possible mechanisms. Future research could use observational techniques to capture parent-adolescent interactions about pain.

Turk (2002) focuses on mechanisms between emotions, cognitions and pain, for example, Turk’s (2002) model describes how anxiety sensitivity can lead to disability via catastrophic attributions about pain. The results of the present study did not examine cognitions about pain, however strong support was found for the role of anxiety in predicting adolescent recurrent pain trajectories. Future research is needed to support whether pain-related cognitions mediate between anxiety and recurrent pain development. Future research in this area could use detailed daily-process measures to track cognitions, anxiety, and painful events as they occur.

Research looking at mechanisms among psychosocial factors and pain must also search for mechanisms in the form of interrelations between underlying vulnerability, precipitating stimuli, and psychological factors. Factors, such as illness/hospitalization, were included in many of the pediatric pain models that exist in the literature, but were not found to be strong predictors of adolescent recurrent pain trajectories. It is possible that the reason no main effects relationships with the adolescent recurrent pain trajectories were seen is because there are important interactions between these and other factors that would predict recurrent pain development. For example, it is possible that experiences with illness/hospitalization lead to the development of recurrent pain only in adolescents who have high levels of depression, or low levels of self-esteem.

The may also be a further explanation of why certain psychosocial factors, such as illness/hospitalization and parent chronic pain, were included in many models for pediatric pain in literature, but were not found to be strong predictors of adolescent recurrent pain
trajectories. As was stated above, it is possible that these factors are associated with concurrent levels of pain, but are not predictive of the long-term course of recurrent pain development. Future models must be explicit in regards to whether they are attempting to describe psychosocial factors that are concurrently associated with pain, factors that are predictive of pain at one future time point, and factors that predict pain trajectories.

Finally, future research must address reciprocal relationships between pain and psychosocial factors. It is also possible that many psychosocial factors, such as anxiety, have reciprocal relationships with longitudinal trajectories of adolescent recurrent pain. The present study considered the role of psychosocial factors in predicting recurrent pain, but it is also possible that recurrent pain predicts psychosocial factors. For example, just as anxiety/depression were shown to lead to the development of recurrent pain, having recurrent pain is also likely to cause anxiety and depression in adolescents. Future studies should investigate trajectories of psychosocial factors, such as anxiety, depression and self-esteem, as consequences of recurrent pain.

In summary, conceptual models for recurrent pain trajectories that include mechanisms and account for dynamic, reciprocal relationships that exist between psychosocial factors and the development of recurrent pain are needed because they will be best able to inform research on how to prevent vulnerable adolescents from experiencing increasing levels of recurrent pain, or from maintaining stable, high frequencies of recurrent pain over time. See Figure 10 for a graphical depiction of the issues related to the psychosocial model for adolescent recurrent pain development that should be investigated in future research.
Future Research on Adolescent Recurrent Pain Development and the NLSCY

Although comprehensive, the present study is just one of many steps required in developing an understanding of the development of recurrent pain throughout adolescence. The large, representative sample size, longitudinal design, and inclusion of a broad range of psychosocial variables made the NLSCY an excellent tool to begin to consider adolescent recurrent pain development. In fact, the NLSCY can be used to address many of the ideas for future research discussed above. The NLSCY can be used to try and answer questions relating to the mechanisms by which the psychosocial factors found, in the present study, to be predictive of recurrent pain lead to its development in adolescence. For example: What relationships exist among underlying vulnerability, precipitating stimuli, and psychological factors that influence recurrent pain development in adolescents?, and more specifically, Does anxiety mediate a pathway of influence between injury avoidance and the development of recurrent pain?, or Do increases in anxiety and/or depression underlie increases in recurrent pain frequencies over the course of adolescence? Another set of studies using the NLSCY could focus on answering questions regarding how recurrent pain influences psychosocial factors. For example: What role does recurrent pain play in the development of psychosocial factors, specifically anxiety and depression? Further research using the NLSCY could also address questions related to the role other psychosocial factors, not tested in the present study, play in the development of adolescent recurrent pain. For example: What other psychosocial variables, such as health behaviours, parenting style, family functioning, peer relationships, academic success, neighbourhood, and SES are important in the development of recurrent pain during adolescence? Although other methods are also necessary to tease apart fine-grained psychosocial and biological mechanisms, the NLSCY remains a
potentially important means to future knowledge about the development of adolescent recurrent pain.

Summary and Conclusions

This research study used a longitudinal population-level approach to study the prevalence, trajectories and predictors of recurrent pain across adolescence. A cohort of 2,488 adolescents from Statistics Canada's NLSCY was studied every 2 years, from ages 10-11 years to ages 18-19 years. Several themes were present in the results of the study. In terms of the prevalence of recurrent pain, high frequencies of recurrent pain were seen across adolescence. Headache, stomachache and backache had different prevalence rates. A subgroup of adolescents were found to experience multiple types of recurrent pain. Weekly recurrent pain rates increased over the course of adolescence only for headache and backache. Finally, girls were seen to have higher rates of pain than boys. In terms of psychosocial factors and recurrent pain trajectories, gender and anxiety/depression appeared to be important to the trajectories of all three types of pain. Despite these common predictors, there was some specificity in certain psychological factors being associated with certain recurrent pain types or components of recurrent pain trajectories (i.e., intercepts versus slopes). Parent headache predicted stable, high headache trajectories over time (i.e., intercepts), but not slopes, nor did parent chronic pain predict stomachache or backache. In contrast, injury and pubertal development were predictive of increasing frequencies (i.e., slopes) of stomachache, but not intercepts, or headache or backache trajectories. Across all three types of recurrent pain, self-esteem was predictive of recurrent pain intercepts, but not slopes. A final theme was that many psychosocial factors, such as general parent chronic pain, illness/hospitalization, and stressful life events, were not found to be predictive in any
of the analyses. Taken together, the results of this study advance knowledge about predictors of longitudinal trajectories of pain in adolescence, but also demonstrate the need for future research to identify the causes and mechanisms that work together to affect recurrent pain trajectories. Alongside gender, psychological factors such as anxiety, depression and self-esteem, are likely to play a role, as are other factors not included in this study, such as biological mechanisms, parent pain behaviours, family functioning, sibling pain, peer relationships, neighbourhood quality and culture. The ultimate goal of this research is to use this knowledge to effectively treat adolescents suffering from recurrent pain and to prevent the development of recurrent pain in at-risk adolescents.
Table 1

**Summary of Recent Population-level Studies on the Prevalence of Pediatric Chronic Pain**

<table>
<thead>
<tr>
<th>Author(s), Year</th>
<th>Sample Size</th>
<th>Geographic Location</th>
<th>Age Range</th>
<th>% Girls</th>
<th>Main Pain Prevalence Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boey, Yap, &amp; Goh, 2000</td>
<td>1,549</td>
<td>Urban and rural Malaysia</td>
<td>11-16 years</td>
<td>50.6</td>
<td>Recurrent abdominal pain: 10.2%.</td>
</tr>
<tr>
<td>Egger, Angold, &amp; Costello, 1998</td>
<td>1,013</td>
<td>North Carolina, USA</td>
<td>9-15 years</td>
<td>Approx. 50</td>
<td>Headache: 10.3%.</td>
</tr>
<tr>
<td>Egger, Costello, Erkanli, &amp; Angold, 1999</td>
<td>3,733</td>
<td>North Carolina, USA</td>
<td>9-16 years</td>
<td>44.3</td>
<td>Stomachache: 2.8%, Musculoskeletal pain: 2.2%.</td>
</tr>
<tr>
<td>El-Metwally, Salminen, Auvinen, Kautiainen, &amp; Mikkelsson, 2006</td>
<td>1,756</td>
<td>Lahti, Finland</td>
<td>9-13 years</td>
<td>(not stated)</td>
<td>Lower limb pain: 18.3%</td>
</tr>
<tr>
<td>Ghandour, Overpeck, Huang, Kogan, &amp; Scheidt, 2004</td>
<td>8,250</td>
<td>USA</td>
<td>(not stated) (Grades 6-10)</td>
<td>100</td>
<td>Headache: 29.1%. Stomachache: 20.7%. Backache: 23.6%.</td>
</tr>
<tr>
<td>Groholt, Stigum, Nordhagen, &amp; Kohler, 2003</td>
<td>6,630</td>
<td>Sweden, Iceland, Norway, Finland &amp; Denmark</td>
<td>7-17 years</td>
<td>Approx. 49</td>
<td>Headache: 14.9%. Stomachache: 8.3%. Backache: 4.7%.</td>
</tr>
<tr>
<td>Hakala, Rimpela, Salminen, Virtanen, &amp; Rimpela, 2002</td>
<td>189,894</td>
<td>Finland</td>
<td>12-18 years</td>
<td>(not stated)</td>
<td>Neck/shoulder pain: 24-45% girls, 12-19% boys across 14-18 years. Lower back pain: 8-14% girls; 7-17% boys across 14-18 years.</td>
</tr>
<tr>
<td>Larsson &amp; Sund, 2005</td>
<td>2,355</td>
<td>Two counties in central Norway</td>
<td>12-15 years</td>
<td>50.5</td>
<td>Headache: 8.1-8.9% (11.5-13.3% girls, 4.6-4.8% boys).</td>
</tr>
<tr>
<td>Perquin et al., 2000</td>
<td>6,636</td>
<td>Rotterdam, The Netherlands</td>
<td>0-18 years</td>
<td>42</td>
<td>25% experience chronic pain of some type.</td>
</tr>
<tr>
<td>Ramchandani, Hotopf, Sandhu, &amp; Stein, 2005</td>
<td>13,971</td>
<td>Avon, England</td>
<td>2-6 years</td>
<td>47.1</td>
<td>Recurrent abdominal pain: 3.8% for 2-year-olds, 6.9% for 3-year-olds, 11.8% for 6-year-olds.</td>
</tr>
</tbody>
</table>
Table 2

*Cohort Size, Age in Years and Percent Female across the Five Survey Cycles*

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Unweighted Cohort Size</th>
<th>Weighted Cohort Size</th>
<th>Mean Age (SD)</th>
<th>Age Range</th>
<th>Percent Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,488</td>
<td>792,192</td>
<td>10.50 (0.50)</td>
<td>10-11</td>
<td>48.7</td>
</tr>
<tr>
<td>2</td>
<td>2,271</td>
<td>703,703</td>
<td>12.46 (0.57)</td>
<td>11-14</td>
<td>48.4</td>
</tr>
<tr>
<td>3</td>
<td>1,919</td>
<td>671,383</td>
<td>14.35 (0.65)</td>
<td>12-16</td>
<td>48.5</td>
</tr>
<tr>
<td>4</td>
<td>1,655</td>
<td>585,123</td>
<td>16.43 (0.64)</td>
<td>14-18</td>
<td>49.8</td>
</tr>
<tr>
<td>5</td>
<td>1,415</td>
<td>514,250</td>
<td>18.27 (0.64)</td>
<td>17-20</td>
<td>48.9</td>
</tr>
</tbody>
</table>

*Note.* Other than in the column labeled 'Unweighted Cohort Size', all results reflect the application of the Cycle 1 non-normalized national longitudinal survey weight.
Table 3

**Summary of Measures in the Recurrent Pain Development Model**

<table>
<thead>
<tr>
<th>Type of Psychosocial Factor</th>
<th>Psychosocial Factor</th>
<th>Brief Description of NLSCY Measure</th>
<th>Reporter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent Pain</td>
<td>n/a</td>
<td>Frequency of headache, stomachache and backache.</td>
<td>Adolescent</td>
</tr>
<tr>
<td>Underlying Vulnerability</td>
<td>Gender</td>
<td>Demographic question.</td>
<td>Parent</td>
</tr>
<tr>
<td></td>
<td>Pubertal status</td>
<td>Mean score based on level of physical development (Girls: body hair, breasts, menstruation; Boys: body hair, voice, facial hair).</td>
<td>Adolescent</td>
</tr>
<tr>
<td></td>
<td>Parent chronic pain</td>
<td>Frequency of arthritis, back pain, sinusitis, migraines, cancer, and stomach ulcers.</td>
<td>Parent</td>
</tr>
<tr>
<td>Precipitating Stimuli</td>
<td>Injury</td>
<td>Mean score based on number of injuries requiring medical attention in the past year.</td>
<td>Parent</td>
</tr>
<tr>
<td></td>
<td>Illness/Hospitalization</td>
<td>Whether adolescent has been an overnight patient in the hospital due to illness.</td>
<td>Parent</td>
</tr>
<tr>
<td></td>
<td>Stressful life events</td>
<td>Mean score based on number of events that have caused adolescent great worry or unhappiness (e.g., death in family, move, family conflict, etc.).</td>
<td>Parent</td>
</tr>
<tr>
<td>Psychological Factors</td>
<td>Anxiety/Depression</td>
<td>Mean score based on number of items related to anxiety/depression items endorsed.</td>
<td>Adolescent, Parent, Teacher</td>
</tr>
<tr>
<td></td>
<td>Self-esteem</td>
<td>Mean score based on number of self-esteem items endorsed.</td>
<td>Adolescent</td>
</tr>
</tbody>
</table>
Table 4

**Pair-wise Pearson Correlations among Psychological Predictors**

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Pub Dev</th>
<th>Par CP</th>
<th>Par Head</th>
<th>Par Stom</th>
<th>Par Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1.00</td>
<td>0.012**</td>
<td>0.031</td>
<td>0.07**</td>
<td>-0.002</td>
<td>0.02</td>
</tr>
<tr>
<td>(Girls = 1)</td>
<td>(Boys = 0)</td>
<td>(n = 2,488)</td>
<td>(n = 2,001)</td>
<td>(n = 2,481)</td>
<td>(n = 2,481)</td>
<td>(n = 2,481)</td>
</tr>
<tr>
<td>Pub Dev</td>
<td>1.00</td>
<td>0.02</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Par CP</td>
<td>0.031</td>
<td>0.02</td>
<td>0.59**</td>
<td>0.50**</td>
<td>0.66**</td>
<td>0.11**</td>
</tr>
<tr>
<td>Par Head</td>
<td>0.07**</td>
<td>0.04</td>
<td>0.04</td>
<td>0.11**</td>
<td>0.15**</td>
<td>0.28**</td>
</tr>
<tr>
<td>Par Stom</td>
<td>-0.002</td>
<td>0.04</td>
<td>0.50**</td>
<td>0.11**</td>
<td>0.11**</td>
<td>1.00</td>
</tr>
<tr>
<td>Par Back</td>
<td>0.02</td>
<td>-0.02</td>
<td>0.66**</td>
<td>0.15**</td>
<td>0.15**</td>
<td>0.08*</td>
</tr>
<tr>
<td>Injury</td>
<td>-0.04*</td>
<td>0.03</td>
<td>0.11**</td>
<td>0.03</td>
<td>0.03</td>
<td>0.13**</td>
</tr>
<tr>
<td>Ill/Hosp</td>
<td>0.01</td>
<td>0.01</td>
<td>-0.002</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.001</td>
</tr>
<tr>
<td>SLE</td>
<td>0.03</td>
<td>0.05*</td>
<td>0.22**</td>
<td>0.08**</td>
<td>0.08**</td>
<td>0.19**</td>
</tr>
<tr>
<td>Adol Anx/Dep Par</td>
<td>0.09**</td>
<td>0.01</td>
<td>0.05*</td>
<td>0.06**</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Adol Anx/Dep Teach</td>
<td>0.04*</td>
<td>0.02</td>
<td>0.13**</td>
<td>0.13**</td>
<td>0.04*</td>
<td>0.10**</td>
</tr>
<tr>
<td>Anx/Dep Self-Est</td>
<td>0.04</td>
<td>-0.03</td>
<td>0.10**</td>
<td>0.07*</td>
<td>0.05</td>
<td>0.08**</td>
</tr>
<tr>
<td>Self-Est</td>
<td>-0.01</td>
<td>-0.06*</td>
<td>-0.02</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.03</td>
</tr>
</tbody>
</table>

Note. Pub Dev = Pubertal Development; Par CP = Parental Chronic Pain; Par Head = Parent Headache; Par Stom = Parent Stomachache; Par Back = Parent Backache; Ill/Hosp = Illness/Hospitalization; SLE = Stressful Life Events; Adol Anx/Dep = Adolescent-report of adolescent anxiety/depression; Par Anx/Dep = Parent-report of adolescent anxiety/depression; Teach Anx/Dep = Teacher-report of adolescent anxiety/depression, Self-Est = Self-Esteem. All results reflect the application of the Cycle 1 normalized national longitudinal survey weight. (*) indicates correlations that are significant at p < 0.05; (**) indication correlations that are significant at p < 0.01. Due to missing data, sample size ranged across correlations between n = 1,261 and n = 2,488 (Mdn = 2,081).
Table 4 Continued

**Pair-wise Pearson Correlations Among Psychological Predictors**

<table>
<thead>
<tr>
<th></th>
<th>Injury (M = 0.20)</th>
<th>Ill/Hosp (M = 0.03)</th>
<th>SLE (M = 0.04)</th>
<th>Adol Anx/Dep (M = 1.49)</th>
<th>Par Anx/Dep (M = 1.37)</th>
<th>Teach Anx/Dep (M = 1.39)</th>
<th>Self-Est (M = 4.33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury</td>
<td>1.00</td>
<td>-0.01</td>
<td>0.07** (n = 2,458)</td>
<td>0.05* (n = 2,468)</td>
<td>0.09** (n = 2,468)</td>
<td>0.02 (n = 2,459)</td>
<td>-0.05* (n = 2,081)</td>
</tr>
<tr>
<td>Ill/Hosp</td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLE</td>
<td>0.07**</td>
<td>0.07**</td>
<td>1.00 (n = 2,468)</td>
<td>0.15** (n = 2,001)</td>
<td>0.38** (n = 2,459)</td>
<td>0.14** (n = 1,266)</td>
<td>-0.13**</td>
</tr>
<tr>
<td>Adol Anx/Dep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Par Anx/Dep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teach Anx/Dep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Est</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Pub Dev = Pubertal Development; Par CP = Parental Chronic Pain; Par Head = Parent Headache; Par Stom = Parent Stomachache; Par Back = Parent Backache; Ill/Hosp = Illness/Hospitalization; SLE = Stressful Life Events; Adol Anx/Dep = Adolescent-report of adolescent anxiety/depression; Par Anx/Dep = Parent-report of adolescent anxiety/depression; Teach Anx/Dep = Teacher-report of adolescent anxiety/depression, Self-Est = Self-Esteem. All results reflect the application of the Cycle 1 normalized national longitudinal survey weight. (* ) indicates correlations that are significant at $p < 0.05$; (**) indication correlations that are significant at $p < 0.01$. Due to missing data, sample size ranged across correlations between $n = 1,261$ and $n = 2,488$ (Mdn = 2,081).
Table 5

*Relationships between headache, stomachache and backache trajectories*

<table>
<thead>
<tr>
<th>Types of Recurrent Pain</th>
<th>Trajectory Component</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>p Value</th>
<th>Standardized Parameter Estimate (β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache &amp; Stomachache</td>
<td>Start-point intercept</td>
<td>3.62</td>
<td>0.36</td>
<td>&lt; 0.001</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>End-point intercept</td>
<td>4.11</td>
<td>0.49</td>
<td>&lt; 0.001</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>Slope</td>
<td>0.42</td>
<td>0.06</td>
<td>&lt; 0.001</td>
<td>0.74</td>
</tr>
<tr>
<td>Headache &amp; Backache</td>
<td>Start-point intercept</td>
<td>2.80</td>
<td>0.33</td>
<td>&lt; 0.001</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>End-point intercept</td>
<td>2.29</td>
<td>0.36</td>
<td>&lt; 0.001</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Slope</td>
<td>0.26</td>
<td>0.04</td>
<td>&lt; 0.001</td>
<td>0.60</td>
</tr>
<tr>
<td>Stomachache &amp; Backache</td>
<td>Start-point intercept</td>
<td>2.50</td>
<td>0.28</td>
<td>&lt; 0.001</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>End-point intercept</td>
<td>2.51</td>
<td>0.35</td>
<td>&lt; 0.001</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>Slope</td>
<td>0.31</td>
<td>0.06</td>
<td>&lt; 0.001</td>
<td>0.71</td>
</tr>
</tbody>
</table>

*Note.* All results reflect the application of the Cycle 1 normalized national longitudinal survey weight. The analyses completed in this table were done using Mplus version 4.0.
Table 6

*Psychosocial Factors and Headache Slope*

<table>
<thead>
<tr>
<th>Type of Psychosocial Factor</th>
<th>Psychosocial Factor</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>p Value</th>
<th>Standardized Parameter Estimate (β)</th>
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<tbody>
<tr>
<td>Underlying Vulnerability</td>
<td>Gender</td>
<td>0.46</td>
<td>0.08</td>
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<tr>
<td></td>
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<td>0.01</td>
</tr>
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<td>0.16</td>
<td>ns</td>
<td>-0.07</td>
</tr>
<tr>
<td>Precipitating Stimuli</td>
<td>Injury</td>
<td>-0.08</td>
<td>0.08</td>
<td>ns</td>
<td>-0.08</td>
</tr>
<tr>
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<td>-0.16</td>
<td>0.16</td>
<td>ns</td>
<td>-0.05</td>
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<tr>
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<td>Stressful life events</td>
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<td>Adolescent-report of Anxiety &amp;/or Depression</td>
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<tr>
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<td>0.12</td>
<td>ns</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>Teacher-report of Anxiety &amp;/or Depression</td>
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<td>0.13</td>
<td>ns</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Self-Esteem</td>
<td>-0.02</td>
<td>0.08</td>
<td>ns</td>
<td>-0.03</td>
</tr>
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</table>

*Note.* All results reflect the application of the Cycle 1 normalized national longitudinal survey weight.
Table 7

*Psychosocial Factors and Stomachache Slope*

<table>
<thead>
<tr>
<th>Type of Psychosocial Factor</th>
<th>Psychosocial Factor</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>p Value</th>
<th>Standardized Parameter Estimate (β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underlying Vulnerability</td>
<td>Gender</td>
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<td>0.38</td>
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<td>-0.38</td>
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<tr>
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<tr>
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<td>ns</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>Parent stomachache</td>
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<td>0.24</td>
<td>ns</td>
<td>-0.01</td>
</tr>
<tr>
<td>Precipitating Stimuli</td>
<td>Injury</td>
<td>-0.20</td>
<td>0.08</td>
<td>&lt; 0.05</td>
<td>-0.18</td>
</tr>
<tr>
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<td>Illness/ Hospitalization</td>
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<td>0.22</td>
<td>ns</td>
<td>-0.02</td>
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<tr>
<td></td>
<td>Stressful life events</td>
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<td>-0.05</td>
</tr>
<tr>
<td>Psychological Factors</td>
<td>Adolescent-report of Anxiety &amp;/or Depression</td>
<td>-0.35</td>
<td>0.14</td>
<td>&lt; 0.05</td>
<td>-0.20</td>
</tr>
<tr>
<td></td>
<td>Parent-report of Anxiety &amp;/or Depression</td>
<td>0.47</td>
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<td>&lt; 0.01</td>
<td>0.27</td>
</tr>
<tr>
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<td>Teacher-report of Anxiety &amp;/or Depression</td>
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<td>0.18</td>
<td>ns</td>
<td>-0.19</td>
</tr>
<tr>
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<td>Self-Esteem</td>
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<td>0.08</td>
<td>ns</td>
<td>-0.11</td>
</tr>
<tr>
<td>Gender by Predictor Interaction</td>
<td>Gender by Teacher Report of Anxiety &amp;/or Depression</td>
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</table>

Note. All results reflect the application of the Cycle 1 normalized national longitudinal survey weight. Only the significant gender by predictor interaction terms were included in the model.
Table 8

**Psychosocial Factors and Backache Slope**

<table>
<thead>
<tr>
<th>Type of Psychosocial Factor</th>
<th>Psychosocial Factor</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>p Value</th>
<th>Standardized Parameter Estimate (β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underlying Vulnerability</td>
<td>Gender</td>
<td>0.15</td>
<td>0.08</td>
<td>ns</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Pubertal status</td>
<td>-0.20</td>
<td>0.14</td>
<td>ns</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>Parent chronic pain</td>
<td>-0.28</td>
<td>0.40</td>
<td>ns</td>
<td>-0.06</td>
</tr>
<tr>
<td></td>
<td>Parent backache</td>
<td>0.25</td>
<td>0.16</td>
<td>ns</td>
<td>0.15</td>
</tr>
<tr>
<td>Precipitating Stimuli</td>
<td>Injury</td>
<td>-0.08</td>
<td>0.07</td>
<td>ns</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>Illness/Hospitalization</td>
<td>0.23</td>
<td>0.18</td>
<td>ns</td>
<td>-0.08</td>
</tr>
<tr>
<td></td>
<td>Stressful life events</td>
<td>0.71</td>
<td>0.67</td>
<td>ns</td>
<td>0.10</td>
</tr>
<tr>
<td>Psychological Factors</td>
<td>Adolescent-report of Anxiety &amp;/ or Depression</td>
<td>-0.17</td>
<td>0.14</td>
<td>ns</td>
<td>-0.12</td>
</tr>
<tr>
<td></td>
<td>Parent-report of Anxiety &amp;/ or Depression</td>
<td>-0.02</td>
<td>0.15</td>
<td>ns</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>Teacher-report of Anxiety &amp;/or Depression</td>
<td>-0.10</td>
<td>0.15</td>
<td>ns</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>Self-Esteem</td>
<td>-0.04</td>
<td>0.08</td>
<td>ns</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

*Note.* All results reflect the application of the Cycle 1 normalized national longitudinal survey weight.
Figure 1

Psychosocial Model for the Development of Adolescent Recurrent Pain (Headache, Stomachache or Backache)

Underlying Vulnerability
- Gender
- Pubertal Status
- Parent with Chronic Pain

Precipitating Stimuli
- Injury
- Hospitalization / Illness
- Stressful Life Events

Psychological Factors
- Anxiety &/or Depression
- Self-Esteem

Development of Adolescent Recurrent Pain (Headache, Stomachache or Backache)
Figure 2

Headache Frequency in the Past 6 Months

Note. All data points in the graph above reflect the application of the Cycle 1 non-normalized national longitudinal survey weight. Standard errors, calculated used the unweighted sample size at each cycle, ranged between 0.002 and 0.013. Percent reporting headache occurring weekly or more: Cycle 2 (12-13 years) = 26.2, Cycle 3 (14-15 years) = 31.8, Cycle 4 (16-17 years) = 28.7, Cycle 5 (18-19 years) = 28.3.
Figure 3

*Stomachache Frequency in the Past 6 Months*

Note. All data points in the graph above reflect the application of the Cycle 1 non-normalized national longitudinal survey weight. Standard errors, calculated using the unweighted sample size at each cycle, ranged between 0.003 and 0.021. Percent reporting headache occurring weekly or more: Cycle 2 (12-13 years) = 19.8, Cycle 3 (14-15 years) = 22.2, Cycle 4 (16-17 years) = 13.6, Cycle 5 (18-19 years) = 13.5.
Note. All data points in the graph above reflect the application of the Cycle 1 non-normalized national longitudinal survey weight. Standard errors, calculated using the unweighted sample size at each cycle, ranged between 0.004 and 0.012. Percent reporting headache occurring weekly or more: Cycle 2 (12-13 years) = 17.6, Cycle 3 (14-15 years) = 25.0, Cycle 4 (16-17 years) = 23.5, Cycle 5 (18-19 years) = 25.8.
Figure 5

*Prevalence of Multiple Weekly or More Frequent Pains*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Head &amp; Stomach</td>
<td>11.8</td>
<td>14.7</td>
<td>8.0</td>
<td>7.3</td>
</tr>
<tr>
<td>Head &amp; Back</td>
<td>10.1</td>
<td>14.4</td>
<td>10.2</td>
<td>10.5</td>
</tr>
<tr>
<td>Stomach &amp; Back</td>
<td>8.1</td>
<td>11.6</td>
<td>5.7</td>
<td>6.1</td>
</tr>
</tbody>
</table>

*Note.* All results reflect the application of the Cycle 1 non-normalized national longitudinal survey weight.
Figure 6

Prevalence of Weekly or More Headache by Gender

Note. All results reflect the application of the Cycle 1 non-normalized national longitudinal survey weight. Chi-square tests indicated that girls had higher frequencies of headache than boys, at all ages: 12-13 years: \( n = 1,932.76, \chi^2(3) = 25.73, p < 0.001 \); 14-15 years: \( n = 1,711.89, \chi^2(3) = 150.73, p < 0.001 \); 16-17 years: \( n = 1,544.88, \chi^2(3) = 128.32, p < 0.001 \); 18-19 years: \( n = 1605.72, \chi^2(3) = 151.28, p < 0.001 \).
Figure 7

Prevalence of Weekly or More Stomachache by Gender

Note: All results reflect the application of the Cycle 1 non-normalized national longitudinal survey weight. Chi-square tests indicated that girls had higher frequencies of stomachache than boys, at all ages: 12-13 years: \( n = 1,920.85, \chi^2 (3) = 44.24, p < 0.001 \); 14-15 years: \( n = 1,712.03, \chi^2 (3) = 114.16, p < 0.001 \); 16-17 years: \( n = 1,544.88, \chi^2 (3) = 145.22, p < 0.001 \); 18-19 years: \( n = 1,608.16, \chi^2 (3) = 122.94, p < 0.001 \).
Prevalence of Weekly or More Backache by Gender

Note: All results reflect the application of the Cycle 1 non-normalized national longitudinal survey weight. Chi-square tests indicated that girls had higher frequencies of backache than boys, at all ages: 12-13 years: \( n = 1,923.81, \chi^2(3) = 11.02, p = 0.012; \) 14-15 years: \( n = 1,699.50, \chi^2(3) = 45.48, p < 0.001; \) 16-17 years: \( n = 1,544.88, \chi^2(3) = 27.34, p < 0.001; \) 18-19 years: \( n = 1,608.16, \chi^2(3) = 47.65, p < 0.001.\)
Figure 9.

Psychosocial Model for the Development of Adolescent Recurrent Pain
(Headache, Stomachache or Backache) Based on the Results of the Present Study

Note. Factors in bold were shown to predict adolescent recurrent pain development across pain-type and trajectory-type. Factors not in bold were shown to predict specific types of recurrent pain and/or recurrent pain trajectories. Factors with a strike-through were not shown to be predictive of adolescent recurrent pain development.
Issues to be Addressed in Future Research on the Psychosocial Model for the Development of Adolescent Recurrent pain (Headache, Stomachache, Backache)

Note. Dotted lines refer to constructs and pathways that need to be tested in future research. Floating text boxes indicate potentially important factors that need to be addressed by future research in order to be integrated into the model.
Reference List


Grunau, R. E., Whitfield, M. F., & Petrie, J. (1998). Children's judgements about pain at age 8-10 years: Do extremely low birthweight (< or = 1000 g) children differ from full


