Version: Post-print

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The epidemiology of chronic pain in children and adolescents revisited:

A systematic review

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Abstract

Chronic and recurrent pain not associated with a disease are very common in childhood and adolescence, but studies of pain prevalence have yielded inconsistent findings. This systematic review examined studies of chronic and recurrent pain prevalence to provide updated aggregated prevalence rates. The review also examined correlates of chronic and recurrent pain such as age, sex, and psychosocial functioning. Studies of pain prevalence rates in children and adolescents published in English or French between 1991 and 2009 were identified using EMBASE, Medline, CINAHL, and PsycINFO databases. Of 185 published papers yielded by the search, 58 met inclusion criteria and were reviewed and 41 were included in the review. Two independent reviewers screened papers for inclusion, extracted data and assessed the quality of studies. The range and median prevalence rates for specific types of pain were as follows: Headache: Median = 23%; Abdominal Pain: Median 19%; Back Pain: Median = 21%; Musculoskeletal Pain: Median = 29%; Multiple Pains: Median = 11%; Other Pains: Median = 38%. Pain prevalence rates were generally higher in girls and increased with age for most pain types. Lower socioeconomic status was associated with higher pain prevalence especially for headache). Most studies did not meet quality criteria.

The epidemiology of chronic pain in children and adolescents revisited: a systematic review

Although precise definitions vary, the International Association for the Study of Pain (IASP) typically defines chronic pain as pain lasting more than three months {{863 Merskey,H. 1994}}. Chronic pain can be either recurrent or persistent and is a serious developmental health concern that can interfere significantly with daily functioning {{455 Palermo,T.M. 2000; 456 Palermo,T.M. 2005; }}. Children experiencing persistent or recurrent chronic pain (hereafter referred to as chronic pain) may miss school, withdraw from social activities, and are at risk of developing internalizing symptoms in response to their pain {{390 McGrath,P.J. 1986; 440 Oddson,B.E. 2006; 455 Palermo,T.M. 2000; }}. Given these consequences, issues related to pediatric chronic pain (e.g., prevalence, age of onset, epidemiology, etiology, assessment, and treatment) are important to researchers and clinicians to enable the development of effective strategies to ameliorate these problems.

Studies examining the prevalence of childhood pain have yielded inconsistent findings. For example, population-based studies of headache in children have found prevalence rates estimated anywhere from 23% to 51% {{82 Brun Sunblad,G.M. 2007; 691 Perquin,C.W. 2000; 695 Stanford,E.A. 2008; }}. Similarly, prevalence rates for abdominal pain have been shown to range between 10% and 27% {{719 Goodman,J.E. 1991; }}. Because prevalence rates vary considerably across studies, it is difficult to make general conclusions regarding the pervasiveness of different pains in children and adolescents. There are few comprehensive summaries of pain epidemiology in childhood and adolescence. The most recent comprehensive review was published in *Pain* 20 years

ago {{719 Goodman,J.E. 1991; }} and was the first and only paper to provide such a summary. Goodman and McGrath {{719 Goodman,J.E. 1991; }} also identified several methodological limitations of these studies that could account, at least in part, for discrepant findings with respect to pain prevalence rates. The use of inappropriate measures, disagreement regarding the definition of various types of pains, and the use of samples inappropriate for epidemiological investigations were noted as methodological concerns {{719 Goodman,J.E. 1991; }}.

Since Goodman and McGrath's pivotal review, significant improvements have been made to study design (e.g., use of population based recruitment, more stringent controls) and a number of epidemiological studies of pediatric pain have been published {{691 Perquin,C.W. 2000; 695 Stanford,E.A. 2008; }}. However, no comprehensive reviews of this epidemiological have been published since 1991, making it difficult to describe prevalence rates of chronic pain in children and adolescents. The objectives of the current review were four-fold: (1) to provide an updated examination of epidemiological studies of pediatric chronic pain; (2) to use both systematic and narrative methods to provide a more objective summary of the literature; (3) to describe individual factors related to pain prevalence (e.g., age and sex differences and sociodemographic and psychological factors); and (4) to assess study quality as part of the current review to determine whether improvements have been made to methodology since the original review {{719 Goodman,J.E. 1991; }} was published. As noted by Goodman and McGrath {{719 Goodman,J.E. 1991; }}, a more thorough understanding of the epidemiology of pediatric pain is beneficial for the treatment of pain in children and adolescents, and for understanding the antecedents and correlates of adult chronic pain.

Method

Inclusion/Exclusion Criteria

Key electronic database searches (EMBASE, Medline, CINAHL, and PsycINFO) were conducted by a Library Information Specialist using the following search terms: child, adolescent, chronic pain, pediatric pain, recurrent pain, prevalence, incidence, pain epidemiology, headache, abdominal pain, musculoskeletal pain, and back pain. Databases were searched for articles published in English or French between 1991 and 2009. No French articles were located for this time period; therefore, no non-English papers were included in the current review. Two independent reviewers (SK, RM) performed an initial screening using study titles and abstracts. The following details were recorded: number of studies found, number meeting inclusion criteria, number excluded, reason for exclusion, and whether the article needed to be obtained to determine eligibility. Articles that were included by one reviewer but excluded by another were to be decided based on consensus with disagreements to be settled by a third reviewer (the third reviewer was not required). Once agreement had been reached on eligibility, the same two independent researchers reviewed each article in full to determine the significant findings in each study.

Data Extraction

Data were extracted by the two independent reviewers (SK, RM) using customized forms specifying author, type of sample (population/community or school), number of participants, location of study, age range of participants, sex of participants, prevalence rate, and other findings of note (e.g., socioeconomic differences in pain prevalence, increasing prevalence rates over time, associated psychosocial variables such

as anxiety and depression). Studies meeting inclusion criteria were categorized according to the type of pain investigated, as follows: (1) headache only; (2) abdominal pain only; (3) back pain only; (4) musculoskeletal pain; (5) combined pain; and (6) other/general pain. The "other/general pain" category was included to capture recurrent pains other than those previously described (e.g., recurrent earaches or throat pain) or studies in which children were asked whether they had experienced any kind of pain in a specified time period.

Assessment of Study Quality

A set of criteria for evaluating the quality of epidemiological studies of pain was compiled using existing sources {{852 Elwood,J.M. 2007; 849 Loney,P.L.; 850 Loney,P.L. 1999; 851 Zaccai,J.H. 2004; }}, as well as other quality criteria for epidemiological studies (i.e., STROBE; {{864 von Elm,E. 2007}}) as guidelines. The decision to develop a new set of criteria rather than using the existing STROBE criteria was due to the need to include items specific to the study of pain and to address the concerns raised by Goodman and McGrath {{719 Goodman,J.E. 1991; }}. The final criteria consisted of a total of 19 items; however, two of these items were not appropriate for those studies using self-administered questionnaires instead of interviews as the primary data collection method (see Table 8). Each item was scored as "1" if the criterion was met and "0" if the criterion was not met. Items scored as "unclear" were rated by a second reviewer. Therefore, quality scores for epidemiological studies using interview methodology could range from 0 to 19, whereas quality scores for studies using self-report measures could range from 0 to 17, with higher scores indicating higher study quality. Each study included in this review was coded on each of the quality criteria by

one of the study co-authors (AH). Twenty-five percent of these studies were randomly

selected to be coded by the lead author (SK) to establish percent agreement between

coders. Coders were not blind to study authors or study findings.

<div align="center">Results</div>

Search Results

The database search yielded a total of 185 citation abstracts, with 21 duplicates, 4

book chapters, 15 editorials/commentaries, 24 review articles, and 1 dissertation. Based

on the initial abstract review, 58 studies were retrieved for further review; of these

abstracts, a total of 32 studies met our a priori inclusion criteria and were included in this

review (see Figure 1). Given that the goal of the current review was to summarize

epidemiological findings, a typical meta-analysis using effect sizes was not possible;

therefore, findings were synthesized and described systematically. Given the discrepant

findings with respect to prevalence rates across studies, the median prevalence rate was

used to summarize findings, as this statistic is not influenced by outliers.

Headache Studies

Prevalence. As shown in Table 1, 9 studies (N = 24 230) specifically examined

the prevalence of headache in children. Three studies (N = 5 516) examined headache in

the context of larger studies of multiple pains. In total, 29 746 participants were included

in studies of headache. Prevalence rates ranged widely for this type of pain and were

largely dependent on the time period of reporting (i.e., monthly, weekly or daily

prevalence rates). Three studies investigated prevalence rates over the past month {{685

Carlsson,J. 1996; 697 Petersen,S. 2003; }} or three months {{82 Brun Sunblad,G.M.

2007; 683 Fendrich,K. 2007; }}, with prevalence rates ranging from 26% to 69% in

children aged 7 through 16 years (Median = 47%). Weekly headache prevalence rates in children aged between 7 and 18 years of age were reported in eight studies {{688 Bandell-Hoekstra,I.E. 2001; 687 Barea,L.M. 1996; 82 Brun Sunblad,G.M. 2007; 685 Carlsson,J. 1996; 682 Kristjansdottir,G. 1993; 697 Petersen,S. 2003; 680 Rhee,H. 2000; 695 Stanford,E.A. 2008; }}. Across these studies, prevalence of weekly headache ranged from 6% to 31% (Median = 23%). Finally, two studies presented prevalence rates for daily headache in children aged between 10 and 18 years {{687 Barea,L.M. 1996; 680 Rhee,H. 2000; }}, with rates ranging from 1 % to 9% (Median = 5.1%).

Four headache studies reported prevalence rates for migraine {{689 Abu-Arefeh,I. 1994; 687 Barea,L.M. 1996; 686 Bugdayci,R. 2005; 679 Sillanpaa,M. 1996; }} and three reported prevalence rates for tension-type headaches {{689 Abu-Arefeh,I. 1994; 687 Barea,L.M. 1996; 686 Bugdayci,R. 2005; }}. Prevalence rates for migraine with and without aura ranged from 3% to 10% (Median = 8%), whereas prevalence rates for tension-type headache ranged much more widely, from 1% to 73% (Median = 25%).

Age differences. Age appears to be an important influence on headache prevalence among children. Four studies reported that headache prevalence increased with increasing age in children and adolescents {{686 Bugdayci,R. 2005; 685 Carlsson,J. 1996; 683 Fendrich,K. 2007; 697 Petersen,S. 2003; }}, whereas one study reported that headaches were more prevalent in younger children {{682 Kristjansdottir,G. 1993; }}. Carlsson {{685 Carlsson,J. 1996; }} reported a gradual increase in prevalence of headache "one a month or more" with increasing age, from 16% in grade one to 42% in grade nine. These authors also reported a marked increase in headache prevalence between grades two and three, with prevalence rates increasing from 3% to 11%. In their study of headache in a

sample of German children and adolescents, Fendrich et al. {{683 Fendrich,K. 2007; }} also found that headache prevalence increased with age; however, this trend was observed in girls only; a similar trend was reported by Petersen, Bergstrom, and Brulin {{697 Petersen,S. 2003; }}. Perhaps the most worrisome finding with respect to headache occurrence in children and adolescents is that prevalence rates appear to be increasing over long periods of time, independent of increasing age of a particular cohort. In a study specifically designed to investigate changes in headache prevalence over time, Sillanpaa and Anttila {{679 Sillanpaa,M. 1996; }} found that, over an 18-year period (i.e., 1974-1992), the prevalence of headache over the last six months increased from 14% to 52% in two samples of Finnish children matched on age and demographics.

Sex differences. Of the 10 studies that reported sex differences in headache prevalence rates {{688 Bandell-Hoekstra,I.E. 2001; 687 Barea,L.M. 1996; 717; 82 Brun Sunblad,G.M. 2007; 686 Bugdayci,R. 2005; 685 Carlsson,J. 1996; 683 Fendrich,K. 2007; 682 Kristjansdottir,G. 1993; 697 Petersen,S. 2003; 680 Rhee,H. 2000; 695 Stanford,E.A. 2008; }}, the majority reported that headaches are more prevalent in girls. Prevalence rates of headache were generally found to be higher in girls than in boys in both elementary and high school students, with more discrepant rates emerging in older children {{688 Bandell-Hoekstra,I.E. 2001; 82 Brun Sunblad,G.M. 2007; 686 Bugdayci,R. 2005; 685 Carlsson,J. 1996; 697 Petersen,S. 2003; 680 Rhee,H. 2000; 695 Stanford,E.A. 2008; }}. Given that these trends were observed in studies conducted in several countries, and that they occur across various samples and ages it is likely that the finding of higher prevalence of headache in girls is not spurious.

Psychosocial factors. One study reported that increased headache prevalence is associated with low socioeconomic status (SES) and other family variables {{686 Bugdayci,R. 2005; }}. Headache prevalence was higher in children from low SES backgrounds, especially if mothers had a low level of education and if there was a positive family history of headache {{686 Bugdayci,R. 2005; }}. Low SES, daycare attendance as a youngster, and increased number of leisure activities were also identified as risk factors for headaches {{679 Sillanpaa,M. 1996; }}. The relation between sociodemographic factors and headache was less clear in other studies examining these variables {{685 Carlsson,J. 1996; 682 Kristjansdottir,G. 1993; 679 Sillanpaa,M. 1996; }}. Generally, these studies found that SES tended to interact with factors such as age and sex to influence headache prevalence in children. In addition to SES, other factors associated with increased headache prevalence include ethnicity {{680 Rhee,H. 2000; }}, depression {{680 Rhee,H. 2000; 695 Stanford,E.A. 2008; }}, anxiety {{695 Stanford,E.A. 2008; }}, and low self-esteem {{680 Rhee,H. 2000; }}. Relations between pain and sex, age, and other psychosocial/sociodemographic factors (as described below) across studies are presented in Table 2.

Abdominal Pain Studies

Prevalence. As shown in Table 3, five studies (N = 21 420) specifically examined the prevalence of abdominal pain in children and a further four examined abdominal pain in the context of wider investigations of multiple pains (N = 6 106), making the total sample size 27 526 children and adolescents. Of these nine studies, five investigated prevalence rates of recurrent abdominal pain (RAP) as defined by Apley and Naish {{718 Apley,J. 1958; }}. According to Apley and Naish {{718 Apley,J. 1958; }}, RAP can be

defined as at least three episodes of abdominal pain, severe enough to limit the child's

functioning, over at least three months. Across the studies examining RAP {{709

Boey,C.C. 1999; 708 Boey,C.C. 2000; 706 Oh,M.C. 2004; 693 Ostkirchen,G.G. 2006;

705 Ramchandani,P.G. 2005; }}, prevalence rates varied fairly widely in children aged

between 2 and 17 years, ranging from 41 % in a small sample of Malaysian 11- and 12-

year-olds {{709 Boey,C.C. 1999; }}, 33.2% in a sample of German preschoolers {{693

Ostkirchen,G.G. 2006; }} to 4% in a sample of 2-year-old children in the UK {{705

Ramchandani,P.G. 2005; }}. The median prevalence rate of RAP across these studies

was 12%. Four studies examined prevalence of abdominal pain in various samples of

children and adolescents {{82 Brun Sunblad,G.M. 2007; 707 Kristjansdottir,G. 1996; 697

Petersen,S. 2003; 695 Stanford,E.A. 2008; }}. Kristjansdottir {{707 Kristjansdottir,G.

1996; }} measured overall lifetime prevalence of stomach pain in Icelandic 11-12 and 15-

16 year-olds and found that 53% of the sample had experienced "frequent" stomach pain

{{707 Kristjansdottir,G. 1996; }}. Four studies examined weekly abdominal pain

prevalence {{82 Brun Sunblad,G.M. 2007; 707 Kristjansdottir,G. 1996; 697 Petersen,S.

2003; 695 Stanford,E.A. 2008; }}, with rates ranging from 8% to 22% (Median = 19%).

　　Age. With respect to age differences in prevalence of RAP, Ramchandani et al.

{{705 Ramchandani,P.G. 2005; }} reported that the prevalence of RAP increases with

age in early childhood. Using data from a large longitudinal cohort study in the United

Kingdom, these authors found that prevalence rates of RAP increased from 4% in 2-year-

old children to 7% in 3-year-old children to 12% in 6-year-old children (Median = 7%).

With respect to age-related differences in stomach pain, Kristjansdottir {{707

Kristjansdottir,G. 1996; }} reported that the prevalence of stomach pain was significantly

higher in younger (23%) as opposed to older children (14%) in 11-12 and 15-16 year-old children from Icelandic. Similar findings were reported by Petersen et al. {{697 Petersen,S. 2003; }}, who noted that prevalence rates for monthly stomach ache increased from 34% to 55% over grades 0 through 6. In contrast to these findings, Boey and colleagues {{708 Boey,C.C. 2000; }} did not find age-related differences in the prevalence of RAP in a sample of Malaysian 11-16 year-olds. These authors also noted that their prevalence rate of 10% was similar to that reported by Apley and Naish {{718 Apley,J. 1958; }}. Similarly, in another study of RAP in South-East Asian children and adolescents, Oh and colleagues {{706 Oh,M.C. 2004; }} reported that prevalence rates of RAP did not increase with increasing age, although these authors noted a prevalence rate of 23 % in their sample - more than twice that of Boey et al. {{708 Boey,C.C. 2000; }}.

Sex. As with headache, sex differences in the prevalence of RAP and stomach pain were observed across these studies. Based on findings from a Canadian sample, Stanford et al. {{695 Stanford,E.A. 2008; }} reported that girls tend to have more pain complaints, including stomach ache, than boys at all ages. Kristjansdottir {{707 Kristjansdottir,G. 1996; }} reported that the prevalence rate of stomach pain was higher in girls overall and that this sex difference was observed in both younger and older children. Specifically, younger girls had a "weekly" prevalence rate of 27% compared to 19% in younger boys. Older girls had a "weekly" prevalence rate of 18% as opposed to 10% in older boys. Older girls reported higher prevalence rates of "monthly" stomach pain as opposed to younger girls 49% and 36%, respectively). Ramchandani and colleagues {{705 Ramchandani,P.G. 2005; }} reported a clear sex difference in RAP, with more girls than reporting symptoms, as did Brun Sundblad et al. {{82 Brun

Sunblad,G.M. 2007; }};10% of girls in their sample reported weekly abdominal pain, as compared to 5% of boys. Oh and colleagues {{706 Oh,M.C. 2004; }} reported similar findings, in that RAP was more common in girls than in boys (OR = 1.7, 95% CI, 1.3-2.1). On the other hand, Boey et al. {{708 Boey,C.C. 2000; }} reported that prevalence of RAP in Malaysian children and adolescents did not differ by sex.

Psychosocial factors. Across studies, findings were mixed with respect to the sociodemographic factors associated with abdominal pain in children and adolescents. In one study that specifically examined sociodemographic factors related to abdominal pain {{707 Kristjansdottir,G. 1996; }}, it was found that SES interacted with age, such that abdominal pain was more prevalent in younger children from lower and middle SES backgrounds. One other study found abdominal pain to be more prevalent in rural children {{708 Boey,C.C. 2000; }}, whereas other authors reported higher prevalence rates of abdominal pain in children from higher social classes {{705 Ramchandani,P.G. 2005; }}. Other factors associated with increased abdominal pain prevalence are anxiety in children and their mothers {{705 Ramchandani,P.G. 2005; }}, anxiety and depression in children {{695 Stanford,E.A. 2008; }}, feelings of sadness in younger girls {{82 Brun Sunblad,G.M. 2007; }}, and school stress {{706 Oh,M.C. 2004; }}.

Back Pain Studies

Prevalence. As shown in Table 4, two studies (*N* = 3 619) specifically examined the prevalence of back pain in children and adolescents. Two studies examined back pain in the context of a larger study investigating multiple pains (*N* = 3 643), making the total number of participants 7 262. As with studies of headache prevalence, reported rates of low back pain varied and were dependent on the time period of reporting. Two studies

reported one-month prevalence rates of back pain ranging from 18% to 24% (Median =

21%) in samples of English and Swedish children {{697 Petersen,S. 2003; 710

Watson,K.D. 2002; }}. Finally, three studies reported prevalence rates of weekly or "at

least weekly" back pain ranging from 9% to 25% (Median = 21%) {{713

Kristjansdottir,G. 1996; 697 Petersen,S. 2003; 695 Stanford,E.A. 2008; }}.

Age. All studies of back pain in children and adolescents included in the current

review reported increasing prevalence rates with age in this population. Kristjansdottir

{{713 Kristjansdottir,G. 1996; }} further noted that older children in rural areas tended to

report more back pain than children in more urban areas (28% and 23%, respectively).

Sex. Sex differences in were not as pronounced in studies of back pain as in

headache and RAP/stomach pain studies, as only one of the above-mentioned studies

noted sex differences with respect to back pain. Watson et al. {{710 Watson,K.D. 2002;

}} reported that the one-month prevalence rate of back pain in a sample of adolescents

between the ages of 11 and 14 was significantly higher in girls (29%) than boys (19%).

Stanford and colleagues {{695 Stanford,E.A. 2008; }} reported that, over the course of

adolescence, girls were more likely to experience higher frequencies of back pain than

boys. The remaining back pain studies reported no sex differences in back pain

prevalence rates.

Psychosocial factors. One of the studies examining back pain included

measurement of psychosocial/emotional functioning. Stanford et al {{695 Stanford,E.A.

2008; }} reported that, when predictors were entered into a regression model separately,

sex and parent- and youth-reported anxiety/depression were predictive of start and end

points of back pain trajectories; however, anxiety/depression was no longer significant

when variables were entered simultaneously. Kristjansdottir {{713 Kristjansdottir,G.

1996; }} measured sociodemographic variables in a study of back pain in Icelandic

children and found that social class was not related to self-reports of back pain, although

there was an interaction between age and living condition with respect to back pain.

Musculoskeletal/Limb Pain Studies

> *Prevalence.* As shown in Table 5, four studies (Total $N = 3\ 842$) specifically

examined the prevalence of musculoskeletal and/or limb pain in children and adolescents.

One study examined musculoskeletal/limb pain in the context of a larger study

investigating multiple pains ($N = 1\ 908$), making the total number of participants 5 750.

Again, prevalence rates varied depending on time period of reporting and calculation of

median prevalence rates was made difficult due to the wide variety of musculoskeletal

pain symptoms reported in each study. Additionally, the relation between

musculoskeletal/limb pain and athletic participation further confounds findings in this

area, as many participants reported that their pain was the result of a sports injury. In a

Norwegian study that asked participants between the ages of 10 and 15 years whether

they "usually" feel pain {{564 Smedbraten,B.K. 1998; }}, results indicated that 25% of

respondents experienced musculoskeletal pain several days a week. Brun Sundblad and

colleagues {{82 Brun Sunblad,G.M. 2007; }} found that weekly musculoskeletal pain

was experienced by only 9% of their sample of children aged 9, 12 or 15 years. In

another study examining prevalence of knee pain in children aged either 9-10 years or 14-

15 years {{700 Vahasarja,V. 1995; }}, the overall prevalence rate was 12%; however

56% of reported pain as linked to athletic participation. Mikkelsson and colleagues {{704

Mikkelsson,M. 1997; }} examined prevalence rates of non-specific musculoskeletal pain

in children between the ages of 9 and 11 years over a three-month period and found that 32% of these children reported pain once a week, whereas 39% experienced pain once a month. In their study of Norwegian children, Brun Sundblad and colleagues {{82 Brun Sunblad,G.M. 2007; }} found that, over a three-month period, 29% of respondents reported experienceing musculoskeletal pain "now and again". Finally, in a Brazilian study examining prevalence rates of musculoskeletal pain in 10-18 year olds {{702 Zapata,A.L. 2006; }}, 40% of respondents indicated that they has experienced musculoskeletal pain at some point during the last six months.

Age. Based on results of these studies, the prevalence rate of musculoskeletal pain in children and adolescents increased with age. Vahasarja {{700 Vahasarja,V. 1995; }} noted that adolescents had significantly more knee pain than children (19% and 4%, respectively); these results were echoed by Zapata et al. {{702 Zapata,A.L. 2006; }}, who also reported increasing rates of musculoskeletal pain with increasing age in their sample. Rhee et al. {{696 Rhee,H. 2005; }} report increasing musculoskeletal pain with increasing age; however, these authors note that this trend is quadratic, with a peak in musculoskeletal pain at age 16. Smedbraten et al. {{564 Smedbraten,B.K. 1998; }} not only report pain prevalence rates increase with age, but that the consequences of musculoskeletal pain (i.e., difficulty concentrating, reliance on medications) also increase with increasing age. Finally, Brun Sundblad and colleagues {{82 Brun Sunblad,G.M. 2007; }} found that the increase in musculoskeletal pain symptoms with increasing age was only evident in girls.

Sex. With respect to sex differences in musculoskeletal pain, the majority of the studies reported that musculoskeletal pain is more common in girls than in boys. For

example, Smedbraten et al. {{564 Smedbraten,B.K. 1998; }}, in their comprehensive study of multiple musculoskeletal pain symptoms, found that girls generally reported pain in more body parts than boys and also reported more frequent pain as compared to boys. Girls reported significantly more pain in the head, neck, shoulders, back, and abdomen as compared to boys, whereas boys reported significantly more knee pain than girls. Zapata et al. {{702 Zapata,A.L. 2006; }} echoed these results, and reported more overall musculoskeletal pain in girls as compared to boys in their sample (34% vs. 11%). Specifically, girls reported significantly more upper limb pain than boys (11% vs. 7%), more soft tissue stress injury (STSI) than boys (27% vs. 9%), more benign joint hypermobility syndrome (BJHS) than boys (14% vs. 5%), and a greater incidence of myofascial syndrome (MFS) compared to boys (7% vs. 2%). Mikkelsson et al. {{704 Mikkelsson,M. 1997; }} also reported that girls reported more pain in the chest and upper back compared to boys. In contrast to these findings, Rhee et al. {{696 Rhee,H. 2005; }} found that boys experienced increased rates of musculoskeletal pain as compared to girls in their study of American adolescents.

Psychosocial factors. Only one of the studies examining musculoskeletal pain examined psychological variables related to pain; therefore, it is difficult to draw firm conclusions as to the impact of these variables on this type of pain. With respect to psychological functioning in children and adolescents experiencing musculoskeletal pain, Brun Sundblad and colleagues {{82 Brun Sunblad,G.M. 2007; }} found that feeling sad was associated with pain in girls, but no psychological variables were associated with musculoskeletal pain in boys.

Combined Pain Studies

Prevalence. As shown in Table 6, three studies (Total *N* = 30 843) specifically examined the prevalence of multiple pains in children and adolescents; that is, these studies combined pain types in order to obtain prevalence rates for these combinations and did not examine single pains {{698 Kristjansdottir,G. 1997; 701 Bakoula,C. 2006; 696 Rhee,H. 2005; }}. Two of the studies (Total *N* = 3 043) noted previously also assessed multiple pains in addition to singular pains {{693 Ostkirchen,G.G. 2006; 695 Stanford,E.A. 2008; }}, resulting in a total of 33 886 participants. Given the wide range of pains examined in these studies, prevalence rates were, again, somewhat variable and were dependent on the time period over which children were asked to respond. In their large scale study of multiple recurrent pains in an American sample of children and adolescents in grades 7 through 12, Rhee and colleagues {{696 Rhee,H. 2005; }} found that the 12-month prevalence rate of combined headache/abdominal pain/musculoskeletal pain was 4%. Prevalence of monthly pain combinations in an Icelandic sample was reported by Kristjansdottir {{698 Kristjansdottir,G. 1997; }}, who found that 16% of respondents reported two pains on a monthly basis. Weekly prevalence rates for multiple pains were reported in three studies {{698 Kristjansdottir,G. 1997; 701 Bakoula,C. 2006; 695 Stanford,E.A. 2008; }}, with rates ranging from 4% to 11% (Median = 6%). One study reported prevalence rates for parent- and child-reported combined headache and abdominal pain in a sample of German children {{693 Ostkirchen,G.G. 2006; }}; the parent-reported prevalence rate for these combined pains was 46%, whereas children reported a prevalence rate of 49%.

Age. Age differences in multiple pain prevalence were not reported by Bakoula et al. {{701 Bakoula,C. 2006; }}; however, Kristjansdottir {{698 Kristjansdottir,G. 1997;

}} reported that 21% of 11-12 year-olds and 14% of 15-16 year-olds have some combination of one, two or three pains. These prevalence rates represent overall findings, however, and rates were varied across age groups depending on the specific pain combination in question (i.e., number of symptoms and site of pain). Rhee and colleagues {{696 Rhee,H. 2005; }}found no significant linear relation between age and total number of symptoms.

Sex. With respect to sex differences in pain combinations, findings were generally consistent with studies of single pains, in that girls tended to report more symptoms than boys. Kristjansdottir {{698 Kristjansdottir,G. 1997; }} found that girls reported higher overall pain scores as compared to boys. In terms of specific pain combinations, 17 % of boys and 16% of the girls had some combination of one, two, or three weekly pains. Again, rates varied depending on specific combinations. Findings from the other study that sought to specifically examine pain combinations in children and adolescents {{701 Bakoula,C. 2006; }} indicated that, in a sample of Greek children, girls reported more recurrent pain than boys (9% vs. 6%). These findings were similar to Rhee et al. {{696 Rhee,H. 2005; }}, who also found that girls were more likely to report multiple pain symptoms than boys.

Psychosocial factors. Although several of the studies of multiple pains examined psychosocial variables in relation to pain, all except one examined the associations between psychosocial variables and single pains. One study {{701 Bakoula,C. 2006; }} examined the relation between psychosocial factors and multiple pain and found that complaints of recurrent chronic pain was significantly correlated with several variables: chronic health problems, frequent change of residence, poor performance at school,

frequent television watching, and fewer interactions with other children. These authors did not find significant associations between pain and family structure or socioeconomic status.

Other/General Pain Studies

Prevalence. As shown in Table 7, five studies ($N = 7\ 051$) specifically examined general (i.e., nonspecific) pain in children and adolescents. As in all other pain categories described thus far, reported prevalence rates for general pain varied and were dependent on the time period of reporting. Three studies {{677 Barajas,C. 2001; 692 Huguet,A. 2008; 690 van Dijk,A. 2006; }} included point prevalence rates of general pain (i.e., pain at time of interview/survey). Point prevalence rates ranged from 5% (chronic pain at time of survey) to 27% (Median = 18%). Van Dijk and colleagues {{690 van Dijk,A. 2006; }} also examined lifetime prevalence rates for various types of pain (i.e., recurring pain, two or more recurring pains, long lasting pain, and chronic pain condition); these rates ranged from 6% (chronic pain condition) to 57% (recurring pain) (Median = 38%). Pain over the past three months was reported in two studies {{692 Huguet,A. 2008; 691 Perquin,C.W. 2000; }} and ranged from 54% to 88% (Median = 71%). Additionally, Perquin and colleagues {{691 Perquin,C.W. 2000; }} reported that chronic pain accounted for 25% of pain in their sample, whereas 24% of pain was described as non-chronic. Finally, pain over the last month was reported in one study {{694 van Dijk,A. 2008; }} and was reported as 60%.

Age. Age differences in pain were reported in three of the five studies. In their study of Spanish school children, Barajas and colleagues {{677 Barajas,C. 2001; }} reported that pain steadily decreased with increasing age in their sample. Prevalence in

younger children was reported to be 33%, whereas prevalence in older children was reported to be 24%; this difference, however, was not statistically significant. Additionally, an age x sex interaction was noted, with higher prevalence rates for girls aged between 6-7 years of age (36%) and boys aged between 8-10 years of age (30%). Perquin and colleagues {{691 Perquin,C.W. 2000; }} reported increasing rates of chronic pain with age in both sexes, noting that 1/3 of adolescents between 12-15 years of age reported chronic pain. Finally, Huguet and Miro {{692 Huguet,A. 2008; }} also found an increase in chronic pain with increasing age; especially in girls than in boys.

Sex. As with other studies of specific types of pain, general pain was reported to be more prevalent in girls than in boys. Perquin and colleagues {{691 Perquin,C.W. 2000; }} found that girls reported chronic pain more frequently than boys, with a considerable increase in chronic pain in girls between the ages of 12-14 years. These results were echoed by Huguet and Miro {{692 Huguet,A. 2008; }}, who found that, in their sample of Spanish children and adolescents, the prevalence of chronic pain was higher in girls as opposed to boys, regardless of age. Some interesting trends were also noted with respect to sex differences in pain: chronic lower limb pain was more common in boys than girls (57% vs. 19.7%), whereas chronic pain at multiple sites was more common in girls than in boys (51% vs. 22%).

Psychosocial factors. Two of the five studies of general pain {{692 Huguet,A. 2008; 694 van Dijk,A. 2008; }} examined psychosocial variables and the impact of pain in children and adolescents. Huguet and Miro {{692 Huguet,A. 2008; }} reported that, for children and adolescents with chronic pain, quality of life (as assessed by the PedsQL) was significantly lower than for children who did not report chronic pain. Fifty-

three percent of children with chronic pain reported visiting a doctor as a result of their

pain, as compared to 30% of children who did not report chronic pain {{692 Huguet,A.

2008; }}. Children with chronic pain were also more likely to use medication for their

pain compared to children without chronic pain (55% vs. 39%). Finally, Huguet and Miro

{{692 Huguet,A. 2008; }} noted that the prevalence rate of chronic pain in their Spanish

sample was not associated with socioeconomic level or with parental marital status. Van

Dijk and colleagues {{694 van Dijk,A. 2008; }} also examined psychological functioning

to some extent in their study of pain in Canadian children and adolescents. Findings from

this study indicated that pain was associated with poor self-rated health, psychological

symptoms (i.e., feeling low, irritable or bad temper, feeling nervous, and difficulties

falling asleep).

Study Quality

With respect to study quality, percent agreement between coders was 96%. As

shown in Table 8, the quality of the studies included in the present systematic review was

generally low-moderate. Specifically, the mean number of criteria met by interview

studies was 4.5/19 ($SD = 2.9$) and the mean for studies using self-report was 9.9/17 ($SD =$

7.7). The range for median number of quality criteria met by each type of study was not

large, ranging from 7 to 9 (see Table 2). The most frequently met criteria were the

following: random recruitment, clearly stating the recruitment process, high response rate

(i.e., > 80 %), and providing information regarding the questions used to assess chronic

or recurrent pain. Areas of weakness included using biased (i.e., convenience) samples,

omitting sample size calculations, omitting analyses of non-responders, and failing to

present demographic information such as age, sex, and SES.

Discussion

The current review systematically examined epidemiological studies of pain in children and adolescents, with a view to updating the literature and evaluating progress made in this area since Goodman and McGrath published their seminal paper in 1991. Additionally, we developed a set of criteria by which to assess the quality of each of the studies included in this review. To our knowledge, this is the first review of epidemiological studies of pediatric pain to employ a systematic approach and to assess study quality. An extensive search of the current literature identified 41 studies of pain epidemiology in non-clinical samples of children and adolescents published since 1991; this is in contrast to the 34 studies (published from 1951 to 1991) identified by Goodman and McGrath {{719 Goodman,J.E. 1991; }}. The greater number of published studies of pain epidemiology in children and adolescents since 1991 suggests that this is an area of interest to researchers in the field and that pain in this population is a pressing health concern worthy of study. Identifying prevalence rates of pain in childhood has important implications for investigating the developmental trajectories of pain and may lead to a more thorough understanding of the development of adult chronic pain conditions.

The current review found that chronic and recurrent pain is an extremely pressing health concern in children and adolescents, with girls generally experiencing more pain than boys and prevalence rates increasing with age. Psychosocial variables impacting pain prevalence included anxiety, depression, low self-esteem, other chronic health problems and low SES. The current study found that pain is an extremely pressing health concern in children and adolescents, with girls generally experiencing more pain than boys and increasing prevalence rates with age. Psychosocial variables impacting pain

prevalence included anxiety, depression, low self-esteem, other chronic health problems and low SES. Overall, headache was found to be the most commonly studied single pain type in youth, with an estimated median prevalence rate of 23%. Other types of pain (i.e., abdominal pain, back pain, musculoskeletal pain, and pain combinations) were less frequently studied than headache and prevalence rates were variable due to differences in reporting; however, overall results indicated that these pain types are highly prevalent in children and adolescents, with median prevalence rates ranging from 11% to 38%. These rates are of great concern, but what is even more concerning is that research suggests that prevalence rates of childhood pain have increased over the last several decades {{688 Bandell-Hoekstra,I.E. 2001; 679 Sillanpaa,M. 1996; }}.

Findings such as this argue that researchers and clinicians alike should be aware of the problem of pain in children and of the long-term consequences of chronic pain in childhood. Indeed, studies of musculoskeletal pain found prevalence rates similar to adult rates, suggesting that at least some types of pain may become chronic in childhood and may be predictive of long-term pain complaints and pain-related disability. The majority of studies included in the current review were conducted using somewhat restricted age ranges and were not longitudinal in nature. As a result of these shortcomings, there are several gaps in our understanding of age differences in pain prevalence rates and the developmental trajectories of pain across the lifespan. In order to fully understand pain prevalence in childhood, as well as the risk factors that predict pain in adulthood, it is essential that pain research adopt a more developmental focus; that is, using wider age ranges and/or conducting more longitudinal studies of pain prevalence will increase

understanding of age differences in pain prevalence. This knowledge will, in turn, lead to a greater understanding of pain prevalence throughout the lifespan.

Findings from this review also indicated that most types of pain are more prevalent in girls than in boys, but the factors that influence this sex difference in pain prevalence are not entirely clear, suggesting that more research investigating the correlates of pain in both girls and boys is necessary. Similarly, pain prevalence rates tend to increase with increasing age (with the exception of abdominal pain, which tends to be more prevalent in younger children). Targeting younger children for interventions may be a key factor in determining whether pain difficulties become chronic or not; therefore more longitudinal research is needed to determine whether early intervention can serve as a protective factor in young children.

Although some of the studies included in the current review included assessment of psychosocial and sociodemograpic factors (e.g., SES, mental health factors, parental factors) influencing the development and maintenance of recurrent and chronic pain in children and adolescents, there is, overall, a dearth of knowledge in this area. Of the studies that examined these factors, it was found that SES, parental education and mental health status, type of residence, and time spent watching television contributed to complaints of pain in children and adolescents. However, the contribution of these variables to the development of long-term pain complaints has not been fully examined, despite being acknowledged as important by several authors. By focusing more epidemiological research on the psychosocial and environmental factors that influence the development of pain complaints, it may be possible to identify those children most in

need of medical or psychological interventions, with the goal of preventing the onset of chronic pain.

Perhaps the most interesting finding from the current study is that, despite suggestions by Goodman and McGrath {{719 Goodman,J.E. 1991; }} regarding operational definitions of pain and accurate reporting of pain intensity, frequency, and duration, there was little consistency across studies with respect to these factors, as indicated by the quality rating component of this review. Specifically, most studies did not provide operational definitions of the type of pain being investigated, making it difficult to accurately ascertain whether acute, recurrent or chronic pain was being studied. For this reason, the current review included all studies that examined recurrent or chronic pain, based on information contained in the abstract or methodology sections. Clearly, providing accurate operational definitions of pain will allow for more specific study of the nature of various types of pain in future studies. Similarly, there was great variability in prevalence rates across studies, mostly due to time periods over which pain was reported. Comparisons among studies will facilitate accurate reporting of pain prevalence rates in children and adolescents across sex, age, and culture.

The lack of consistency between studies in terms of pain definitions and reporting highlights the need to apply a set of standardized quality criteria when examining the epidemiology of pain in children and adolescents. As part of the current study, a set of criteria were developed with which to assess study quality; findings indicated that few studies met the majority of these criteria. Design flaws such as omission of sample size calculations, using biased samples, failing to adequately operationalize the outcome variable (i.e., pain) and omitting demographic information, as well as extremely varied

reporting periods for pain make it difficult to accurately assess prevalence rates in children and adolescents. As suggested by Goodman and McGrath {{719 Goodman,J.E. 1991; }} and reiterated here, future epidemiological studies of chronic pain in children and adolescents should adhere to a set of quality criteria to allow for more direct comparison among studies, as well as advancing understanding of prevalence rates of pediatric pain across regions and cultures. More attention to study quality would facilitate combination of studies for the purposes of obtaining overall prevalence rates and may also lead to improved developmental models of chronic and recurrent pain.

Although this review provides updated prevalence rates and identified key psychosocial variables associated with pediatric chronic pain, as well as provided suggestions for improving the quality of epidemiological studies of childhood pain, some limitations should be acknowledged. First, the estimates of overall pain prevalence provided in this review are based on median prevalence rates. These rates were designed to provide a general estimate of prevalence rates; however, they should be interpreted with caution and the reader is referred back to the original study to obtain more precise prevalence rates. Second, median prevalence rates were used as part of the current review, as the median is not affected by outliers in the data; however, median prevalence rate may still be affected by sample size, in that larger samples would likely result in higher rates of reported pain, thereby creating bias. Given that there is no clear standard in the literature for reporting prevalence rates in epidemiological studies, the current study prioritized sensitivity to outliers over sample size.

In conclusion, results of this review indicate that persistent and recurrent chronic pain is overwhelmingly prevalent in children and adolescents and should be recognized

as a major health concern in this population. The current review identified several demographic and psychosocial factors associated with high prevalent rates of specific pain types; it is suggested that researchers carefully consider these factors when designing and conducting epidemiological studies of pain in youth, as they often play a significant role in the onset and maintenance of chronic pain conditions. By shifting focus to factors associated with chronic and recurrent pain, it may be possible to identify the most salient risk factors for the development of chronic pain in children and adolescents, thereby leading to early and intensive intervention for the most at-risk group. Continued focus in this area could have a dramatic impact on pain prevalence rates and may result in improved quality of life, decreased pain-related disability, and improved outcomes for children and adolescents challenged by chronic pain.

Acknowledgements

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