

NICOLA MCLAREN, MPhil<sup>1</sup> • STEVEN J. KAMPER, PhD<sup>2,3</sup> • REBECCA HODDER, BPsych<sup>1,2,4</sup>  
 JOHN WIGGERS, PhD<sup>1,4</sup> • LUKE WOLFENDEN, PhD<sup>1,4</sup> • JENNIFER BOWMAN, PhD<sup>5</sup>  
 ELIZABETH CAMPBELL, PhD<sup>4</sup> • JULIA DRAY, BPsych<sup>5</sup> • CHRISTOPHER M. WILLIAMS, PhD<sup>1,2,4</sup>

# Increased Substance Use and Poorer Mental Health in Adolescents With Problematic Musculoskeletal Pain

**M**usculoskeletal pain is a leading cause of disability worldwide, with significant economic, societal, and personal impacts.<sup>13,39,45</sup> The Global Burden of Disease study ranks low back pain, neck pain, and other



musculoskeletal disorders as the first, fourth, and 10th health conditions responsible for the most years lived with disability.<sup>13</sup> This burden is not isolated to adults,

with the prevalence of musculoskeletal pain in adolescents approaching that in adults.<sup>26,27</sup> Around one third of adolescents report experiencing musculoskeletal pain on a monthly or more frequent basis,<sup>40</sup> and low back pain and neck pain rank second and eighth of all health conditions for years lived with disability in 15- to 19-year-olds.<sup>13</sup>

Adolescence is also a critical time developmentally, when experimentation with tobacco, alcohol, and illicit drugs often occurs.<sup>44</sup> Early initiation of these behaviors is linked to the development of long-term use.<sup>8,34</sup> Importantly, tobacco smoking, alcohol consumption, and illicit drug use have a substantial impact on health, each being responsible for a significant proportion of the global burden of disease (4%, 4%, and 0.8% of disability-adjusted life-years, respectively).<sup>46</sup> In youth aged 15 to 24 years, alcohol consumption and illicit drug use are the first- and fifth-ranked risk

- **STUDY DESIGN:** Cross-sectional study.
- **BACKGROUND:** Adolescents with musculoskeletal pain are thought to be at greater risk of modifiable health risk behaviors, but little is known about these behaviors in adolescents with problematic pain.
- **OBJECTIVE:** To describe the prevalence of substance use (tobacco smoking, alcohol consumption, and illicit drugs) and poor mental health in adolescents with problematic musculoskeletal pain, compared to those without such pain.
- **METHODS:** Data on self-reported pain, substance use, and poor mental health were collected from 1831 year 9 students (age range, 14-16 years). Participants were considered to have problematic pain if they reported experiencing pain at least monthly over a 6-month period that also required medication or impacted 1 or more of the following: school or work, daily activities, and leisure or sporting activities.
- **RESULTS:** Almost half (46%) of the participants experienced problematic pain. Adolescents with problematic pain, compared to those without pain, reported higher substance use and poorer mental

health: tobacco smoking in the last 4 weeks, 12% versus 7% (odds ratio [OR] = 1.76; 95% confidence interval [CI]: 1.25, 2.28); alcohol consumption in the last 4 weeks, 30% versus 20% (OR = 1.68; 95% CI: 1.34, 2.11); illicit drug use, 13% versus 6% (OR = 2.18; 95% CI: 1.55, 3.07); lower Mental Health Inventory scores ( $\beta$  = -11.43; standard error [SE], 0.96;  $P < .05$ ), indicating poorer mental health; and higher Strengths and Difficulties Questionnaire total scores ( $\beta$  = 3.67; SE, 0.29;  $P < .05$ ), indicating greater difficulties.

- **CONCLUSION:** Adolescents with problematic pain report higher smoking, alcohol use, and use of illicit drugs and poorer mental health than adolescents without problematic pain. The experience of problematic pain could be an important consideration for substance use and chronic disease prevention. This trial is registered with the Australian New Zealand Clinical Trials Registry (reference number ACTRN12611000606987). *J Orthop Sports Phys Ther* 2017;47(10):705-711. doi:10.2519/jospt.2017.7441

- **KEY WORDS:** alcohol consumption, chronic pain, health risk behaviors, illicit drug use, psychological well-being, tobacco smoking

<sup>1</sup>School of Medicine and Public Health, Hunter Medical Research Institute, University of Newcastle, Callaghan, Australia. <sup>2</sup>Centre for Pain, Health and Lifestyle, New South Wales, Australia. <sup>3</sup>School of Public Health, University of Sydney, Sydney, Australia. <sup>4</sup>Hunter New England Population Health, Hunter New England Local Health District, Wallsend, Australia. <sup>5</sup>School of Psychology, University of Newcastle, Callaghan, Australia. Ethical approval for the study was obtained from the Hunter New England Population Health Human Research Ethics Committee (reference number 09/11/18/4.01), the University of Newcastle Human Research Ethics Committee (reference number H-2010-0029), the Aboriginal Health and Medical Research Council (reference number 776/11), and the New South Wales Department of Education and Training State Education Research Approval Process (reference number 2008118). The trial is registered with the Australian New Zealand Clinical Trials Registry (reference number ACTRN12611000606987). Funding for the main trial was provided by the National Health and Medical Research Council (NHMRC) of Australia, NIB Foundation, and Hunter New England Population Health, with infrastructure support from the Hunter Medical Research Institute. Drs Kamper, Wiggers, Wolfenden, Bowman, and Williams receive research funding from the NHMRC and industry, paid directly to their respective institutions. The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article. Address correspondence to Dr Christopher Williams, Hunter New England Population Health, Wallsend, Australia. E-mail: Christopher.M.Williams@hnehealth.nsw.gov.au • Copyright ©2017 *Journal of Orthopaedic & Sports Physical Therapy*®

factors contributing to global disability-adjusted life-years.<sup>18</sup> Substance use during adolescence places individuals at higher risk of disability and mortality early in life, as well as at higher risk of developing chronic diseases in adulthood.<sup>10</sup>

Emerging evidence suggests that there is an association between musculoskeletal pain and smoking and alcohol use in adolescence. A systematic review revealed a significant association between having ever smoked and 12-month prevalence of low back pain (odds ratio [OR] = 1.4), and an even stronger association between current smoking and chronic low back pain (OR = 1.8).<sup>37</sup> Evidence from individual studies concerning the association between alcohol use and pain in adolescents is equivocal. For example, in a study of 1608 adolescents (mean age, 14 years), Heaps et al<sup>19</sup> reported a positive association (OR = 1.5) between back pain and alcohol use, as did Hestbaek et al<sup>21</sup> (OR = 1.7). However, Kovacs et al<sup>28</sup> reported no association in a study of 7048 adolescents. Law et al<sup>29</sup> found that adolescents with mixed chronic pain conditions were less likely to consume alcohol, but it is likely that this difference is explained by the fact that they sampled from a tertiary referral clinic and had a high rate of refusals to participate. Few studies have assessed the association between illicit drug use and pain in adolescents. One cross-sectional study reported no association between spinal pain and marijuana use in 14-year-olds when adjusted for psychosocial factors.<sup>19</sup>

It is well recognized that psychological health and social functioning are strongly related to substance use,<sup>5,38</sup> but the importance of pain in this context is less clear. Given recent evidence suggesting that pain is associated with the same psychosocial factors that influence adolescent substance-use behaviors,<sup>23</sup> mental health problems such as depressive symptoms, anxiety, and coping style may be important factors in the relationship between pain and substance use. If pain is an important player in shaping mental health and substance use in adolescents,

understanding this relationship may inform design and targeting of future preventative programs.

Despite the work conducted to date, there are gaps in the understanding of the relationship between pain and both substance use and mental health in adolescents. In particular, most studies do not differentiate between “any” pain and “problematic” pain, that is, pain that has a substantial impact on life. This is important, because transient or low-intensity pain is not expected to have significant consequences for overall health. The necessity to concentrate our efforts on understanding pain that has measurable consequences on day-to-day functioning has been increasingly recognized by researchers in the area.<sup>33,42</sup> O’Sullivan and colleagues<sup>33</sup> recommend that measurement of adolescent pain include consideration of its impact across multiple domains: care-seeking behavior (health care seeking, medication use) and interference with usual activities (eg, reduced leisure, sport, or work activities; reduced daily activities; school absenteeism).

The aim of this study was to describe the prevalence of substance use (tobacco smoking, alcohol consumption, and illicit drug use) in adolescents with problematic musculoskeletal pain, compared to those without problematic pain. It was hypothesized that substance use would be higher in adolescents with problematic pain. The secondary aim was to describe mental health and psychological well-being in adolescents with problematic musculoskeletal pain, compared to those without such pain.

## METHODS

### Study Design

A CROSS-SECTIONAL STUDY WAS CONDUCTED in a sample of year 9 adolescents (age range, 14–16 years) from the Hunter New England Region of New South Wales, Australia. In Australia, year 9 is typically the 10th year of compulsory education and the third year of secondary education.

The study involved secondary analysis of data from a cluster-randomized controlled trial: the Healthy Schools, Healthy Futures (HSHF) trial.<sup>22</sup> The trial evaluated the effectiveness of a school-based, resilience-focused intervention to decrease tobacco, alcohol, and illicit drug use in adolescents. Students attending the intervention schools received a multiyear, multistrategy intervention addressing both individual and environmental protective factors of resilience, commencing in 2011. Student outcomes and data for this study were assessed 3 years following implementation of the intervention.

Ethical approval for the study was obtained from the Hunter New England Population Health Human Research Ethics Committee (reference number 09/11/18/4.01), the University of Newcastle Human Research Ethics Committee (reference number H-2010-0029), the Aboriginal Health and Medical Research Council (reference number 776/11), the New South Wales Department of Education and Training State Education Research Approval Process (reference number 2008118), and the relevant Catholic Schools Offices. The trial is registered with the Australian New Zealand Clinical Trials Registry (reference number ACTRN12611000606987). The current study conforms to the STROBE statement for reporting of cross-sectional studies.<sup>43</sup>

### Study Population

The HSHF trial enrolled 32 government and Catholic secondary schools. Schools were eligible if they were (1) located in disadvantaged local government areas (defined as a score of less than 1000 on the Index of Relative Socio-Economic Disadvantage<sup>4</sup>) within the Hunter New England Local Health District, and (2) coeducational schools with at least 400 students and enrolled students in years 7 to 10. Schools that enrolled both primary and secondary students, boarding schools, and schools that were selective (eg, single sex) or catered to special needs were not eligible for the trial.

At follow-up for the HSHF trial (2014), students attending year 9 in participating schools were invited to provide outcomes for the current study. Based on cultural advice processes within the project governance, including consultation with a cultural advice group, students identifying as Aboriginal and/or Torres Strait Islander were not asked to provide information on pain outcomes. This decision considered that, as Aboriginal students were already receiving additional survey items relating to connection to community and culture, which were not asked of non-Aboriginal students, the addition of the pain items was not reasonable.

## Outcome Measures

**Data-Collection Procedures** All data were collected via a confidential self-report online survey, under the supervision of research and school staff on school grounds during class time.

**Problematic Pain** The presence of “problematic pain” was determined based on responses to 2 measurement instruments. First, participants answered items adapted from the Health Behaviour in School-Aged Children survey<sup>7</sup> to report whether they had experienced pain in their limbs, muscles, joints, or bones in the last 6 months, and, if yes, the location, duration, intensity, and frequency of pain. Second, participants completed the Pain Self-Efficacy Questionnaire (PSEQ).<sup>32</sup> The PSEQ comprises 10 items that respondents answer on a 7-point Likert scale to report the confidence with which they can perform activities such as household chores, socializing, work, daily activities, and hobbies or leisure activities; accomplish goals; and cope with their pain without medication. The PSEQ has been shown to have acceptable reliability and validity in chronic pain populations.<sup>2</sup>

Adolescents were classified as having problematic pain if they reported having experienced pain at least monthly in the last 6 months and met the predetermined threshold for “pain impact” on 1

or more of the following questions from the PSEQ:

- “I can do some form of work, despite the pain” (“work” included housework, paid and unpaid work, and school-work). (PSEQ item 5; threshold, less than 6)
- “I can do most of the household chores [eg, tidying up, washing dishes, etc], despite the pain.” (PSEQ item 2; threshold, less than 6)
- “I can still do many of the things I enjoy doing, such as hobbies or leisure activity, despite pain.” (PSEQ item 6; threshold, less than 6)
- “I can cope with my pain without medication.” (PSEQ item 7; threshold, less than 6)

The above criteria for pain “impact” were determined based on the work by O’Sullivan et al.<sup>33</sup> The PSEQ items were mapped to O’Sullivan et al’s<sup>33</sup> recommended impact domains: school or work impact (PSEQ item 5), impact on daily activities (item 2), impact on leisure or sporting activities (item 6), and pain coping that requires use of medication (item 7). A score of less than 6 on the PSEQ Likert scale indicates reduced confidence in performing that activity due to pain,<sup>41</sup> and is highly correlated with pain-related disability.<sup>25</sup>

**Substance Use** Student-reported tobacco smoking, alcohol consumption, and illicit drug use were collected using items regularly used in Australian statewide surveys of secondary school student health behaviors.<sup>7</sup> Responses to the following questions were used to categorize substance use:

- “Have you ever smoked even part of a cigarette?” (No/yes)
- “Have you smoked a cigarette in the last 4 weeks?” (No/yes)
- “Have you ever had a drink of alcohol [eg, beer, wine, or alcopops/premix drinks—do not count sips or tastes]?” (No/yes)
- “Have you had any alcoholic drinks, such as beer, wine, or alcopops/premix drinks, in the last 4 weeks [do not count sips or tastes]?” (No/yes)

- “In the last 4 weeks, how many times have you had 5 or more alcoholic drinks in a row?” (None, once, twice, 3 to 6 times, or 7 or more times; dichotomized as none versus other)
- “Have you ever used or tried any illegal drug or pill?” (No/yes)
- “How many times in the last month have you: smoked or used marijuana/cannabis [eg, grass, hash, dope, weed, mull, yandri, ganja, pot, a bong, a joint]?” (None, once or twice, 3 to 5 times, 6 to 9 times, 10 to 19 times, 20 to 39 times, or 40 or more times; dichotomized as none versus other)
- “How many times in the last month have you used any other illegal drug or pill to get “high,” such as inhalants [eg, paint or thinners], hallucinogens [eg, LSD, acid, trips], amphetamines [eg, gas, speed, ice, goey, dexies], ecstasy [XTC, MDMA, bickies], cocaine, or heroin?” (None, once or twice, 3 to 5 times, 6 to 9 times, 10 to 19 times, 20 to 39 times, or 40 or more times; dichotomized as none versus other)

**Mental Health and Psychological Well-Being** The mental health of participants was measured using 2 separate assessment tools: the Strengths and Difficulties Questionnaire (SDQ)<sup>17</sup> and the Mental Health Inventory-5 (MHI-5).<sup>6</sup> The SDQ is a reliable and valid behavioral screening tool<sup>16,31</sup> and measure of child mental health.<sup>14</sup> It consists of 5 subscales, each with 5 items, which represent “externalizing behaviors” (emotional symptoms and peer relationship problems subscales), “internalizing behaviors” (conduct problems and hyperactivity/inattention subscales), and prosocial behavior.<sup>15</sup> The internalizing and externalizing scores are combined to give a total “difficulty” score, and the prosocial behavior is considered “strength.” Higher difficulty scores and lower strength scores indicate emotional and behavioral difficulties (SDQ total range, 0–40).<sup>36</sup> The MHI-5 assesses symptoms of psychological distress (eg, symptoms of anxiety and depression) and psychological well-being (eg, feeling cheerful, interest in and enjoyment

of life).<sup>30</sup> The MHI-5 consists of 5 items, each scored on a 6-point rating scale, with higher scores indicating better mental health, and is considered a reliable and valid measure in adolescents.<sup>6,30</sup>

## Statistical Analysis

Participants were categorized as having problematic pain or no problematic pain, based on the definition previously described. Demographic and pain characteristics of students with problematic pain were compared to those without problematic pain using chi-square analysis. The primary aim was assessed using mixed-effects logistic regression models, with substance use outcomes as dependent variables and problematic pain as the independent variable. Secondary aims were assessed using generalized linear mixed models, with the MHI-5 and SDQ as dependent variables. Data from both intervention and control schools were combined in the analysis. A sensitivity analysis was conducted using only the control-group participants and compared to the main results using all participants. The analyses were performed with SAS Version 9.3 software (SAS Institute Inc, Cary, NC) and adjusted for potential clustering effects at the school level.

## RESULTS

**T**HIS STUDY UTILIZED AVAILABLE data from 1831 year 9 students (88.2% of the total year 9 sample of 2075), of whom 1201 were from schools allocated to the intervention and 630 were from schools allocated to the control arm of the trial. Participant characteristics are presented in **TABLE 1**. The mean age of the study participants was 14.5 years, and 49% were female. Over half of the participants (55%) lived in an area of socioeconomic disadvantage, and 51% lived in a major city.

### Pain

Almost all (92%) participants reported experiencing an episode of musculoskeletal pain within the last 6 months (**TABLE 1**),

TABLE 1	SUMMARY OF PARTICIPANT CHARACTERISTICS BY EXPERIENCE OF PROBLEMATIC PAIN*	
	Problematic Pain (n = 834)	No Problematic Pain (n = 997)
Sex (female), n (%)	440 (52.8)	455 (45.6)
From area of disadvantage, n (%) <sup>†</sup>	446 (53.5)	553 (55.5)
Resides in major city, n (%) <sup>‡</sup>	413 (49.5)	522 (52.4)
Age, y	14.5 ± 0.53	14.5 ± 0.52
Any pain in the last 6 mo, n (%)	834 (100.0)	854 (85.7)
Pain in 2 or more locations, n (%)	617 (74.0)	461 (46.2)
Pain intensity (0-10) <sup>§</sup>	4.94 ± 2.00	3.75 ± 1.97

\*Values are mean ± SD unless otherwise indicated.  
<sup>†</sup>Defined as a score of less than 1000 on the Index of Relative Socio-Economic Disadvantage.<sup>4</sup>  
<sup>‡</sup>Major city as defined by the Australian Standard Geographical Classification-Remoteness Area.<sup>3</sup>  
<sup>§</sup>Average pain intensity when experiencing pain.

and 61% experienced an episode of pain within the past month. Knee and lower leg (44%) were the most common locations of pain, followed by the back (39%).

Overall, 46% of participants experienced problematic pain. Adolescents with problematic pain had significantly more multisite pain than those without problematic pain, with 74% reporting pain in more than 1 location. Girls were more likely to experience problematic pain than boys ( $P < .05$ ).

### Substance Use

Adolescents with problematic pain had higher odds of all substance use behaviors compared to adolescents without problematic pain: ever smoked (25% versus 16%; OR = 1.78; 95% confidence interval [CI]: 1.39, 2.27;  $P < .05$ ), smoked within the last 4 weeks (12% versus 7%; OR = 1.76; 95% CI: 1.25, 2.28;  $P < .05$ ), ever had alcohol (58% versus 41%; OR = 2.01; 95% CI: 1.65, 2.45;  $P < .05$ ), alcohol within the last 4 weeks (30% versus 20%; OR = 1.68; 95% CI: 1.34, 2.11;  $P < .05$ ), risky drinking (17% versus 10%; OR = 1.80; 95% CI: 1.34, 2.41;  $P < .05$ ), and ever used marijuana and/or other illicit drugs (13% versus 6%; OR = 2.18; 95% CI: 1.55, 3.07;  $P < .05$ ) (**TABLE 2**).

### Mental Health

Adolescents with problematic pain had poorer mental health (MHI-5:  $\beta = -11.43$ ;

standard error [SE], 0.96;  $P < .05$ ; SDQ total:  $\beta = 3.67$ ; SE, 0.29;  $P < .05$ ) compared to adolescents without problematic pain (**TABLE 3**). Based on the SDQ internalizing and externalizing subscale scores, adolescents with problematic pain also reported more internalizing problems ( $\beta = 2.10$ ; SE, 0.17;  $P < .05$ ) and externalizing problems ( $\beta = 1.56$ ; SE, 0.17;  $P < .05$ ).

## DISCUSSION

**M**USCULOSKELETAL PAIN WAS COMMON in adolescents in year 9, and almost half (46%) experienced problematic pain. Problematic pain was associated with higher rates of smoking, alcohol use, and other substance use behaviors, and with poorer mental health scores. The increased prevalence of these known risks for chronic disease could be important determinants of poorer future health in these adolescents.

These results are consistent with other evidence showing associations between tobacco smoking, alcohol consumption, and adolescent pain.<sup>19,21,37</sup> However, our study is the first to find an association between musculoskeletal pain and use of illicit drugs in adolescents.<sup>19</sup> An important distinction between previous studies and the present study is that we divided adolescents based on pain with specific functional impact, rather than the report of pain only. This is consistent with our



TABLE 2

## PARTICIPANT-REPORTED SUBSTANCE USE BY EXPERIENCE OF "PROBLEMATIC PAIN"

Health Risk Behaviors	Problematic Pain (n = 834)*	No Problematic Pain (n = 997)*	Odds Ratio <sup>†</sup>
Tobacco			
Ever used	208 (24.9)	155 (15.5)	1.78 (1.39, 2.27) <sup>‡</sup>
Used in the last 4 wk	98 (11.8)	69 (6.9)	1.76 (1.25, 2.28) <sup>‡</sup>
Alcohol			
Ever used	486 (58.3)	408 (40.9)	2.01 (1.65, 2.45) <sup>‡</sup>
Used in the last 4 wk	248 (29.7)	199 (20.0)	1.68 (1.34, 2.11) <sup>‡</sup>
Risky drinking in the last 4 wk <sup>§</sup>	143 (17.1)	100 (10.0)	1.80 (1.34, 2.41) <sup>‡</sup>
Marijuana/other illicit drugs			
Ever used marijuana	105 (12.6)	60 (6.0)	2.24 (1.58, 3.17) <sup>‡</sup>
Ever used other illicit drugs	44 (5.3)	26 (2.6)	2.08 (0.96, 2.75)
Ever used either	109 (13.1)	64 (6.4)	2.18 (1.55, 3.07) <sup>‡</sup>
Any substance use	295 (35.4)	229 (23.0)	1.82 (1.47, 2.26) <sup>‡</sup>

\*Values are n (%).

<sup>†</sup>Values in parentheses are 95% confidence interval.<sup>‡</sup>P < .05.<sup>§</sup>Defined as 5 or more alcoholic drinks in a row on any occasion in the last 4 weeks.

TABLE 3

## MENTAL HEALTH PROBLEMS AND PSYCHOLOGICAL DISTRESS BY EXPERIENCE OF PROBLEMATIC PAIN

	Problematic Pain (n = 834)*	No Problematic Pain (n = 997)*	Regression Coefficient <sup>†</sup>
MHI-5 total <sup>‡</sup>	58.51 ± 21.50	69.93 ± 19.51	-11.43 (0.96) <sup>§</sup>
SDQ internalizing <sup>¶</sup>	7.81 ± 3.74	5.72 ± 3.64	2.10 (0.17) <sup>§</sup>
SDQ externalizing <sup>¶</sup>	8.06 ± 3.67	6.49 ± 3.69	1.56 (0.17) <sup>§</sup>
SDQ prosocial subscale	6.88 ± 2.09	6.95 ± 2.08	-0.07 (0.10)
SDQ total <sup>¶</sup>	15.87 ± 6.23	12.20 ± 6.17	3.67 (0.29) <sup>§</sup>

Abbreviations: MHI-5, Mental Health Inventory-5; SDQ, Strengths and Difficulties Questionnaire.

\*Values are mean ± SD.

<sup>†</sup>Values are beta (standard error).<sup>‡</sup>Scores range from 0 to 100, with higher scores indicating better mental health.<sup>§</sup>P < .05.<sup>¶</sup>Conduct problems and hyperactivity/inattention (range, 0-20; higher scores indicate greater internalizing problems).<sup>¶</sup>Emotional symptoms and peer relationship problems (range, 0-20; higher scores indicate greater externalizing problems).<sup>¶</sup>Total difficulties score (internalizing and externalizing scores; range, 0-40; higher scores indicate greater difficulties).

in children with chronic pain are suggested to lower the risk of substance use due to reduced peer influence.<sup>11,29</sup> The results of our study, however, suggest that problematic pain in adolescents could be part of a cluster of adverse health risk factors that include poorer mental health, as well as increased likelihood of substance use.

Overall, our results provide further evidence that problematic pain in adolescence is an important consideration in overall health and chronic disease. Our study sampled students attending a large number of schools across a wide geographical area, with many reporting problematic pain over a 6-month period. This would suggest that the burden posed by both painful conditions and substance use may not be limited to conditions that lead to health care seeking.<sup>20</sup> Consequently, a population health framework could provide an important perspective in addressing the joint burden of problematic pain and substance use. Our findings point to implications for public health interventions aimed at reducing substance use, and for interventions aimed at reducing pain in clinical populations. Specifically, consideration of pain may be of value in interventions reducing adolescent substance use, and addressing substance use may be important in treating musculoskeletal pain problems in a proportion of adolescents.

Like our study, most previous studies have only assessed cross-sectional relationships. While there is little good evidence that causal relationships run in one direction or the other, the pattern of our results across multiple health risk behaviors and across multiple measures of mental health strongly suggests that substance use, mental health, and problematic pain are linked. This cluster of adverse health risk indicators comes with an increased risk of disability, mortality, and development of chronic diseases in later life.<sup>24</sup> Further investigation of the interactions and temporal relationships between these factors is warranted.

Our results should be considered with respect to several potential limitations.

hypothesis that pain is only associated with an increase in these specific risk behaviors when it is of sufficient impact to affect daily function or usual activities. Our study supports the recommendation that measurement of adolescent pain include consideration of its impacts.<sup>33</sup>

The findings are also consistent with evidence suggesting that teens with pain

have poorer mental health, including internalizing and externalizing problems (SDQ).<sup>12,35</sup> These factors have been reported to have varying effects on substance use.<sup>9</sup> For example, it is well established that depressive symptoms and mental health issues are associated with higher substance use.<sup>1</sup> On the other hand, poorer peer relationships and social functioning

First, as noted, the cross-sectional design limits the capacity to draw causal inferences. This means that clinical implications should be proposed with caution. We included data from both intervention and control groups of the primary trial, meaning that the intervention may have confounded our results. However, our sensitivity analysis using data from the control group only found consistent results, aside from a change in significance for “tobacco use in the last 4 weeks.” It is likely that this inconsistency was due to reduced power from the smaller sample. Also, as our study excluded Aboriginal students in accordance with cultural advice, the result cannot be generalized to Aboriginal young people. Notwithstanding these limitations, a strength of our study is the inclusion of a large sample of adolescents from schools across a geographically and socially diverse health district. The fact that health risk behaviors were measured via a number of different questions adds to interpretability and comparability, and the consistency of the findings across similar measures indicates that the findings are robust.

## CONCLUSION

**P**AIN IN ADOLESCENCE IS COMMON. Adolescents with problematic pain have higher rates of substance use (tobacco smoking, alcohol consumption, and illicit drug use) than adolescents without problematic pain. Problematic pain in adolescents is also associated with increased mental health problems and poorer psychological well-being. Describing pain according to its impacts may better identify adolescents with an elevated risk of poor health, currently and into the future.

## KEY POINTS

**FINDINGS:** Musculoskeletal pain was common in adolescents in year 9 of secondary school, with 46% experiencing problematic pain, defined by broader impact on function and normal duties. Problematic pain was associated with

higher rates of smoking, alcohol use, and other substance use behaviors, and with poorer mental health scores.

**IMPLICATIONS:** The cluster of these comorbid health concerns could be an important phenomenon in the development of chronic disease.

**CAUTION:** This was a cross-sectional study in a large, albeit single, region of New South Wales, Australia.

**ACKNOWLEDGMENTS:** *The authors thank the staff and students from participating schools and the HSHF project team. We also thank Christophe Lecathelinais for statistical support. For the duration of the research project, an HSHF Aboriginal Cultural Steering Group, made up of Aboriginal staff from local Aboriginal community organizations and government departments, was established to provide Aboriginal cultural advice and direction regarding the design, implementation, evaluation, and dissemination of all research trial elements. Similarly, an HSHF Cultural Advice Group was established consisting of Aboriginal staff from the HSHF project team to provide advice regarding the research trial. We would like to thank the members of both the HSHF Aboriginal Cultural Steering Group and the HSHF Cultural Advice Group for their ongoing advice.*

## REFERENCES

1. Armstrong TD, Costello EJ. Community studies on adolescent substance use, abuse, or dependence and psychiatric comorbidity. *J Consult Clin Psychol.* 2002;70:1224-1239.
2. Asghari A, Nicholas MK. Pain self-efficacy beliefs and pain behaviour. A prospective study. *Pain.* 2001;94:85-100. [https://doi.org/10.1016/S0304-3959\(01\)00344-X](https://doi.org/10.1016/S0304-3959(01)00344-X)
3. Australian Bureau of Statistics. Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure. Canberra, Australia: Australian Bureau of Statistics; 2011.
4. Australian Bureau of Statistics. Census of Population and Housing -- Socio-Economic Indexes for Areas, Australia, 2001. Canberra, Australia: Australian Bureau of Statistics; 2003.
5. Balogun O, Koyanagi A, Stickley A, Gilmour S, Shibuya K. Alcohol consumption and psychological distress in adolescents: a multi-country study. *J Adolesc Health.* 2014;54:228-234. <https://doi.org/10.1016/j.jadohealth.2013.07.034>
6. Berwick DM, Murphy JM, Goldman PA, Ware JE, Jr., Barsky AJ, Weinstein MC. Performance of a five-item mental health screening test. *Med Care.* 1991;29:169-176.
7. Centre for Epidemiology and Research. New South Wales School Students Health Behaviours Survey: 2008 Report. North Sydney, Australia: New South Wales Department of Health; 2009.
8. Chassin L, Presson CC, Sherman SJ, Edwards DA. The natural history of cigarette smoking: predicting young-adult smoking outcomes from adolescent smoking patterns. *Health Psychol.* 1990;9:701-716.
9. Colder CR, Scalco M, Trucco EM, et al. Prospective associations of internalizing and externalizing problems and their co-occurrence with early adolescent substance use. *J Abnorm Child Psychol.* 2013;41:667-677. <https://doi.org/10.1007/s10802-012-9701-0>
10. Eaton DK, Kann L, Kinchen S, et al. Youth risk behavior surveillance—United States, 2009. *MMWR Rep.* 2010;59:1-142.
11. Fite PJ, Colder CR, O'Connor RM. Childhood behavior problems and peer selection and socialization: risk for adolescent alcohol use. *Addict Behav.* 2006;31:1454-1459. <https://doi.org/10.1016/j.addbeh.2005.09.015>
12. Forgeron PA, King S, Stinson JN, McGrath PJ, MacDonald AJ, Chambers CT. Social functioning and peer relationships in children and adolescents with chronic pain: a systematic review. *Pain Res Manag.* 2010;15:27-41.
13. Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet.* 2015;386:743-800. [https://doi.org/10.1016/S0140-6736\(15\)60692-4](https://doi.org/10.1016/S0140-6736(15)60692-4)
14. Goodman A, Goodman R. Strengths and Difficulties Questionnaire as a dimensional measure of child mental health. *J Am Acad Child Adolesc Psychiatry.* 2009;48:400-403. <https://doi.org/10.1097/CHI.0b013e3181985068>
15. Goodman A, Lamping DL, Ploubidis GB. When to use broader internalising and externalising subscales instead of the hypothesised five subscales on the Strengths and Difficulties Questionnaire (SDQ): data from British parents, teachers and children. *J Abnorm Child Psychol.* 2010;38:1179-1191. <https://doi.org/10.1007/s10802-010-9434-x>
16. Goodman R. Psychometric properties of the Strengths and Difficulties Questionnaire. *J Am Acad Child Adolesc Psychiatry.* 2001;40:1337-1345. <https://doi.org/10.1097/00004583-200111000-00015>
17. Goodman R, Meltzer H, Bailey V. The Strengths and Difficulties Questionnaire: a pilot study on the validity of the self-report version. *Int Rev Psychiatry.* 2003;15:173-177. <https://doi.org/10.1080/0954026021000046137>

18. Gore FM, Bloem PJ, Patton GC, et al. Global burden of disease in young people aged 10-24 years: a systematic analysis. *Lancet*. 2011;377:2093-2102. [https://doi.org/10.1016/S0140-6736\(11\)60512-6](https://doi.org/10.1016/S0140-6736(11)60512-6)
19. Heaps N, Davis MC, Smith AJ, Straker LM. Adolescent drug use, psychosocial functioning and spinal pain. *J Health Psychol*. 2011;16:688-698. <https://doi.org/10.1177/1359105310386822>
20. Henschke N, Harrison C, McKay D, et al. Musculoskeletal conditions in children and adolescents managed in Australian primary care. *BMC Musculoskelet Disord*. 2014;15:164. <https://doi.org/10.1186/1471-2474-15-164>
21. Hestbaek L, Leboeuf-Yde C, Kyvik KO. Are lifestyle-factors in adolescence predictors for adult low back pain? A cross-sectional and prospective study of young twins. *BMC Musculoskelet Disord*. 2006;7:27. <https://doi.org/10.1186/1471-2474-7-27>
22. Hodder RK, Freund M, Bowman J, et al. A cluster randomised trial of a school-based resilience intervention to decrease tobacco, alcohol and illicit drug use in secondary school students: study protocol. *BMC Public Health*. 2012;12:1009. <https://doi.org/10.1186/1471-2458-12-1009>
23. Hoftun GB, Romundstad PR, Rygg M. Factors associated with adolescent chronic non-specific pain, chronic multisite pain, and chronic pain with high disability: the Young-HUNT Study 2008. *J Pain*. 2012;13:874-883. <https://doi.org/10.1016/j.jpain.2012.06.001>
24. Johnson NB, Hayes LD, Brown K, Hoo EC, Ethier KA. CDC National Health Report: leading causes of morbidity and mortality and associated behavioral risk and protective factors—United States, 2005-2013. *MMWR Suppl*. 2014;63:3-27.
25. Kaivanto KK, Estlander AM, Moneta GB, Vanharanta H. Isokinetic performance in low back pain patients: the predictive power of the Self-Efficacy Scale. *J Occup Rehabil*. 1995;5:87-99. <https://doi.org/10.1007/BF02109912>
26. Kamper SJ, Henschke N, Hestbaek L, Dunn KM, Williams CM. Musculoskeletal pain in children and adolescents. *Braz J Phys Ther*. 2016;20:275-284. <https://doi.org/10.1590/bjpt-rbf.2014.0149>
27. King S, Chambers CT, Huguat A, et al. The epidemiology of chronic pain in children and adolescents revisited: a systematic review. *Pain*. 2011;152:2729-2738. <https://doi.org/10.1016/j.pain.2011.07.016>
28. Kovacs FM, Gestoso M, Gil del Real MT, López J, Mufraggi N, Méndez JI. Risk factors for non-specific low back pain in schoolchildren and their parents: a population based study. *Pain*. 2003;103:259-268. [https://doi.org/10.1016/S0304-3959\(02\)00454-2](https://doi.org/10.1016/S0304-3959(02)00454-2)
29. Law EF, Bromberg MH, Noel M, Groenewald C, Murphy LK, Palermo TM. Alcohol and tobacco use in youth with and without chronic pain. *J Pediatr Psychol*. 2015;40:509-516. <https://doi.org/10.1093/jpepsy/jsu116>
30. Marques SC, Pais-Ribeiro JL, Lopez SJ. Use of the "Mental Health Inventory - 5" with Portuguese 10-15 years old. *Span J Psychol*. 2011;14:478-485. [https://doi.org/10.5209/rev\\_SJOP.2011.v14.n1.43](https://doi.org/10.5209/rev_SJOP.2011.v14.n1.43)
31. Muris P, Meesters C, van den Berg F. The Strengths and Difficulties Questionnaire (SDQ): further evidence for its reliability and validity in a community sample of Dutch children and adolescents. *Eur Child Adolesc Psychiatry*. 2003;12:1-8. <https://doi.org/10.1007/s00787-003-0298-2>
32. Nicholas MK. The Pain Self-Efficacy Questionnaire: taking pain into account. *Eur J Pain*. 2007;11:153-163. <https://doi.org/10.1016/j.ejpain.2005.12.008>
33. O'Sullivan PB, Beales DJ, Smith AJ, Straker LM. Low back pain in 17 year olds has substantial impact and represents an important public health disorder: a cross-sectional study. *BMC Public Health*. 2012;12:100. <https://doi.org/10.1186/1471-2458-12-100>
34. Paavola M, Vartiainen E, Haukkala A. Smoking, alcohol use, and physical activity: a 13-year longitudinal study ranging from adolescence into adulthood. *J Adolesc Health*. 2004;35:238-244. <https://doi.org/10.1016/j.jadohealth.2003.12.004>
35. Rees CS, Smith AJ, O'Sullivan PB, Kendall GE, Straker LM. Back and neck pain are related to mental health problems in adolescence. *BMC Public Health*. 2011;11:382. <https://doi.org/10.1186/1471-2458-11-382>
36. Richter J, Sagatun Å, Heyerdahl S, Oppedal B, Røysamb E. The Strengths and Difficulties Questionnaire (SDQ) - self-report. An analysis of its structure in a multiethnic urban adolescent sample. *J Child Psychol Psychiatry*. 2011;52:1002-1011. <https://doi.org/10.1111/j.1469-7610.2011.02372.x>
37. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between smoking and low back pain: a meta-analysis. *Am J Med*. 2010;123:87e7-87e35. <https://doi.org/10.1016/j.amjmed.2009.05.028>
38. Stickley A, Koyanagi A, Koposov R, Schwab-Stone M, Ruchkin V. Loneliness and health risk behaviours among Russian and U.S. adolescents: a cross-sectional study. *BMC Public Health*. 2014;14:366. <https://doi.org/10.1186/1471-2458-14-366>
39. Storheim K, Zwart JA. Musculoskeletal disorders and the Global Burden of Disease study. *Ann Rheum Dis*. 2014;73:949-950. <https://doi.org/10.1136/annrheumdis-2014-205327>
40. Swain MS, Henschke N, Kamper SJ, Gobina I, Ottová-Jordan V, Maher CG. An international survey of pain in adolescents. *BMC Public Health*. 2014;14:447. <https://doi.org/10.1186/1471-2458-14-447>
41. Tonkin L. The Pain Self-Efficacy Questionnaire. *Aust J Physiother*. 2008;54:77.
42. von Baeyer CL. Interpreting the high prevalence of pediatric chronic pain revealed in community surveys. *Pain*. 2011;152:2683-2684. <https://doi.org/10.1016/j.pain.2011.08.023>
43. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Prev Med*. 2007;45:247-251. <https://doi.org/10.1016/j.ypmed.2007.08.012>
44. Wiefierink CH, Peters L, Hoekstra F, Dam GT, Buijs GJ, Paulussen TG. Clustering of health-related behaviors and their determinants: possible consequences for school health interventions. *Prev Sci*. 2006;7:127-149. <https://doi.org/10.1007/s1121-005-0021-2>
45. Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. *Bull World Health Organ*. 2003;81:646-656.
46. World Health Organization. Neuroscience of Psychoactive Substance Use and Dependence. Geneva, Switzerland: World Health Organization; 2004.



**MORE INFORMATION**  
[WWW.JOSPT.ORG](http://WWW.JOSPT.ORG)

## FIND Author Instructions & Tools on the Journal's Website

JOSPT's instructions to authors are available at [www.jospt.org](http://www.jospt.org) by clicking **Complete Author Instructions** in the right-hand Author Center widget on the home page, or by visiting the **Info Center for Authors**, located in the site's top navigation bar. The Journal's editors have assembled a list of **useful tools and links** for authors as well as reviewers.