

Sport participation, sport injury, risk factors and sport safety practices in Calgary and area junior high schools

CA Emery BScPT PhD^{1,2}, H Tyreman²

CA Emery, H Tyreman. Sport participation, sport injury, risk factors and sport safety practices in Calgary and area junior high schools. *Paediatr Child Health* 2009;14(7):439-444.

OBJECTIVES: To examine rates of sport participation, sport injury, risk factors and sport safety practices in young adolescents.

DESIGN: Cross-sectional.

SETTING: Calgary and area junior high schools.

PARTICIPANTS: A random sample of 1466 students (aged 12 to 15 years).

OUTCOME MEASURES: Sport injury within one year prior to completing the survey.

RESULTS: Ninety-three per cent of students participated in sports in the previous year. The injury rate was 60.85 injuries/100 students/year (95% CI 58.29 to 63.35) for students reporting at least one sport injury, 29.4 injuries/100 students/year (95% CI 27.08 to 31.81) for medically treated injuries, and 12.28 injuries/100 students/year (95% CI 10.64 to 14.07) for injuries presenting to a hospital emergency department. The greatest proportion of injuries occurred in basketball (14%), soccer (12%), hockey (8.6%) and snowboarding/skiing (7.1%).

CONCLUSIONS: The rates of participation and injury in sports are high in junior high school students. Future research should focus on prevention strategies in sports with high participation and injury rates to have the greatest population health impact.

Key Words: Adolescent; Athletic injury; Epidemiology; Prevention; Risk factors

There is a high level of youth participation in sports (1,2). In Canada, it is estimated that 43% of young adolescents (aged 12 to 15 years), and 35% of older adolescents and young adults (aged 16 to 21 years) participate in organized sports outside of physical education classes at least once a week (2). Participation in sports is critical because decreased physical activity has been shown to increase the risk of morbidity and mortality associated with many diseases (3-6).

In Canada, sport injury is the leading cause of injury in youths (7-9). It is estimated that one in four adolescents (aged 15 to 19 years) and one in seven children (aged six to 14 years) annually require medical attention for a sport injury (9,10). Internationally, sport and recreational injury accounts for 32% to 55% of all injuries in boys (aged 11 to 15 years) and 19% to 59% of all injuries in girls (aged 11 to 15 years) across eight countries (11). Sport injuries, particularly knee and ankle injuries, may result in an increased risk of development of osteoarthritis later in life (3,4). It is also estimated that 8%

La participation aux activités sportives, les blessures sportives, les facteurs de risque et les pratiques de sécurité dans les sports dans les écoles secondaires de premier cycle de Calgary et de la région

OBJECTIFS : Examiner les taux de participation aux activités sportives, de blessures sportives, de facteurs de risque et de pratiques de sécurité dans les sports chez les jeunes adolescents.

MÉTHODOLOGIE : Étude transversale.

LIEU : Écoles secondaires de premier cycle de Calgary et de la région.

PARTICIPANTS : Échantillon aléatoire de 1 466 élèves de 12 à 15 ans.

MESURES D'ISSUE : Blessure sportive dans l'année précédant le sondage.

RÉSULTATS : Quatre-vingt-treize pour cent des élèves ont participé à des activités sportives au cours de l'année précédente. Le taux de blessure était de 60,85 blessures/100 élèves/année (95 % IC 58,29 à 63,35) chez les élèves qui avaient subi au moins une blessure sportive, de 29,4 blessures/100 élèves/année (95 % IC 27,08 à 31,81) pour ce qui est des blessures ayant nécessité un traitement médical et de 12,28 blessures/100 élèves/année (95 % IC 10,64 à 14,07) en ce qui a trait aux blessures ayant entraîné une visite à l'urgence d'un hôpital. La plus forte proportion de blessures se produisait au basketball (14 %), au soccer (12 %), au hockey (8,6 %) et à la planche à neige ou au ski (7,1 %).

CONCLUSIONS : Les taux de participation à des activités sportives et de blessures sportives sont élevés chez les élèves du premier cycle de l'école secondaire. Les prochaines études devraient porter sur les stratégies de prévention dans les sports suscitant un fort taux de participation et un fort taux de blessures afin qu'elles aient le plus de répercussions sur la santé de la population.

of youth discontinued recreational sporting activities annually because of injury, which could lead to less than optimal health in the future (12).

There are many risk factors that may predispose youths to injury in sports, even before the inciting mechanism of injury (13). Risk factors may be extrinsic (eg, rules of play) or intrinsic (eg, age, strength). Modifiable risk factors refer to those that have the potential to be altered by injury prevention strategies (eg, strength) (13). Identification of nonmodifiable risk factors (eg, age) will also assist in determining high-risk populations.

Target sports and populations must be identified before developing and evaluating intervention prevention strategies in youth sports that will have the greatest public health impact. Poor uptake of injury prevention strategies targeting high school students (aged 15 to 18 years) has been demonstrated (14). There may be a greater uptake of injury prevention efforts that target younger adolescents. Therefore, the objectives of the present study were to identify sport participation rates,

¹Department of Community Health Science, Faculty of Medicine; ²Sport Medicine Centre, Roger Jackson Centre for Health and Wellness Research, Faculty of Kinesiology, University of Calgary, Calgary, Alberta

Correspondence: Dr Carolyn A Emery, Sport Medicine Centre, University of Calgary, 2500 University Drive Northwest, Calgary, Alberta

T2N 1N4. Telephone 403-220-4608, fax 403-220-9489, e-mail caemery@ucalgary.ca

Accepted for publication February 5, 2009

sport injury rates, risk factors and sport safety practices in junior high school students (aged 12 to 15 years).

METHODS

A retrospective survey design was used to examine sport participation, sport injury, risk factors and safety practices in Calgary, Alberta, and area junior high school students. The study sample comprised junior high school students (grades 7 to 9, aged 12 to 15 years) from 35 Calgary and area high schools. These schools were randomly selected to participate, based on a computer generation of random numbers, from 120 Calgary and area high schools from five school boards. From each school, one class was randomly selected from each of grades 7, 8 and 9. Junior high school students completed a 30 min Web-based questionnaire in the school computer laboratory in the spring of 2006 following informed consent as per the Office of Medical Bioethics, University of Calgary (Calgary). A research coordinator was present at all survey sessions to ensure that the questionnaires were completed independently. This questionnaire was developed and validated previously (10,15). The variables covered in the questionnaire included subject demographics, sport participation, injury and safety practices in the previous year.

Outcome definition

Sport injury was defined as a positive response to the question: "In the past one year have you had at least one sports injury?" Students who responded positively were asked to respond to additional questions regarding "their most serious injury".

Risk factor definitions

Students were asked to report their age, sex, ethnicity and where they lived (ie, city, small town [population with more than 1000 people] or rural area). As a measure of social economic status, students were asked to report the highest educational level achieved by each of their parents, on a seven-point scale ranging from less than grade 7 to postgraduate university. Students were asked to report their height and weight, from which body mass index (BMI) was calculated in kg/m^2 . BMI was divided into six categories based on the 10th, 25th, 50th, 75th and 90th percentiles. As a measure of exposure to sports, students were asked to report the number of hours per week and the number of months that they participated in their top three sports. Exposure was also divided into six categories based on the 10th, 25th, 50th, 75th and 90th percentiles. Risk-taking behaviours examined included smoking, drinking and seatbelt use. Students were also asked about stressful life events.

Statistical methods

Statistical analyses were performed using Stata (Stata Corporation, USA). In addition to descriptive analyses, a multivariate logistic regression (allowing for clustering within schools) was developed, with all of the potential predictor variables considered for inclusion. Only those predictor variables that approximated the 5% level of significance were included in the final model. All possible two-way interactions were examined.

RESULTS

Study participants

A total of 35 schools, representing five school boards and all communities in and surrounding Calgary, participated in the present survey study. Forty-two school principals declined to participate in the present study because of other school commitments. Of 2154 students who were requested to participate, 1466 students (68.1%) returned a signed parental consent form and completed at least part of the survey. Participant characteristics are summarized in Table 1.

Sport participation

The results indicated that 93.38% (95% CI 91.99% to 94.6%) of students participated in a sport in the previous year. Overall, 70.53% (95% CI 68.12% to 72.86%) of students participated in at least one sport in a club or organized community setting, and/or school team. Sixty-four per cent of students participated in sports for at least 1 h per week. Students were asked about the three sports that they played most often. Sport participation rates were highest for basketball (28.4%), soccer (22.3%), volleyball (19.9%), badminton (19.9%), cycling (14%), running/track and field (13.6%), and hockey (13.2%), although more than 80 sports and activities were identified. Sex-specific participation rates are shown in Figure 1.

Sport injury rates

Of 1466 participating students, 892 reported at least one sport injury in the previous year (injury rate of 60.85 injuries/100 students/year [95% CI 58.29 to 63.35]). Overall, 40.79% (95% CI 38.26 to 43.36) of students reported multiple injuries. The injury rate was 29.4 injuries/100 students/year (95% CI 27.08 to 31.81) for injuries requiring medical attention (eg, physician, physiotherapist), 12.28 injuries/100 students/year (95% CI 10.64 to 14.07) for injuries presenting to a hospital emergency department, and 36.3 injuries/100 adolescents/year (95% CI 33.82 to 38.81) for injuries that resulted in a time loss from sport of at least one day. Sport-specific injury rates are summarized in Figure 2. Injury rates by participant characteristics are summarized in Table 1.

Most serious injury characteristics

The greatest proportion of injuries occurred in basketball (14%), soccer (12%), hockey (8.6%), snowboarding/skiing (7.1%) and cycling (6.2%). The ankles (21.2%) and knees (15.7%) were the most frequently injured body parts, followed by the wrists (8.4%), head (7.51%) and hands (7.51%). The most common injury types were ligament sprains (23.9%), fractures (16.03%) and muscle strains (14.7%). On examining sex-specific injury rates by injury type, boys were more likely to sustain fractures ($\text{OR}_{\text{Female}}=0.63$, 95% CI 0.44 to 0.92), concussions ($\text{OR}_{\text{Female}}=0.48$, 95% CI 0.26 to 0.86) and bleeding injuries ($\text{OR}_{\text{Female}}=0.61$, 95% CI 0.39 to 0.95), and girls to sustain ligament sprain ($\text{OR}_{\text{Female}}=1.42$, 95% CI 1.02 to 1.98) and muscle strain injuries ($\text{OR}_{\text{Female}}=1.55$, 95% CI 1.04 to 2.35) (Figure 3).

TABLE 1
Study participant characteristics and injury rates

Characteristic	n (%)	Sports injury, n (%)
Sex		
Male	616 (42.02)	388 (62.99)
Female	821 (56)	502 (61.14)
(Missing)	29	
Age, years		
12	332 (22.65)	388 (62.99)
13	506 (34.52)	202 (60.83)
14	476 (32.47)	299 (62.82)
15	117 (7.98)	66 (56.41)
(Missing)	35	
Ethnicity		
Caucasian	1112 (75.85)	723 (65.02)
Non-Caucasian	354 (24.15)	169 (47.74)
(Missing)	0	
Home location		
Calgary	792 (54.02)	482 (60.86)
Other town (>1000 people)	372 (25.38)	246 (66.13)
Rural (farm)	86 (5.87)	60 (69.77)
Rural	101 (6.89)	69 (68.32)
(Missing)	115	
Mother's education		
< High school	86 (5.87)	57 (66.28)
High school	336 (22.92)	205 (61.01)
Postsecondary	380 (25.92)	242 (63.68)
University	592 (40.38)	380 (64.18)
(Missing)	72	
Father's education		
< High school	133 (9.07)	77 (57.89)
High school	280 (19.1)	168 (60.0)
Postsecondary	321 (21.9)	196 (61.06)
University	656 (44.75)	439 (66.92)
(Missing)	76	
Body mass index, kg/m ²		
<16 (<10th percentile)	141 (9.62)	84 (59.57)
16–17 (10th to 25th percentile)	209 (14.26)	140 (66.99)
>17–19 (25th to 50th percentile)	353 (24.08)	226 (64.02)
>19–21 (50th to 75th percentile)	345 (23.53)	207 (60.0)
>21–23 (75th to 90th percentile)	204 (13.92)	138 (67.65)
>23 (>90th percentile)	136 (9.28)	84 (61.76)
(Missing)	78	
Exposure, h/week		
<1 (<10th percentile)	133 (9.07)	56 (42.11)
1–2 (10th to 25th percentile)	194 (13.23)	120 (61.86)
>2–4 (25th to 50th percentile)	337 (22.99)	217 (64.39)
>4–6 (50th to 75th percentile)	316 (21.56)	219 (69.3)
>6–8 (75th to 90th percentile)	198 (13.51)	143 (72.22)
>8 (>90th percentile)	130 (8.87)	93 (71.54)
(Missing)	158	
Coaching		
None	299 (20.4)	142 (47.49)
1 sport	364 (24.83)	232 (63.74)
2 sports	388 (26.47)	283 (72.94)
3 sports	253 (17.26)	189 (74.7)
(Missing)	162	
Stressful life events (previous year)		
Yes	452 (29.88)	290 (64.16)
No	971 (66.23)	601 (61.89)
(Missing)	57	

TABLE 1 – CONTINUED
Study participant characteristics and injury rates

Characteristic	n (%)	Sports injury, n (%)
Smoking		
Some	26 (1.77)	16 (61.54)
Never	1369 (93.38)	874 (63.84)
(Missing)	71	
Drinking		
≥1 per week	20 (1.36)	14 (70.0)
<1 per week	144 (9.82)	98 (68.08)
None	1230 (83.9)	778 (63.25)
(Missing)	72	
Seatbelt		
Always or mostly	1248 (85.13)	801 (64.18)
Sometimes or rarely	92 (6.28)	59 (64.13)
Never	54 (3.68)	30 (55.56)
(Missing)	72	

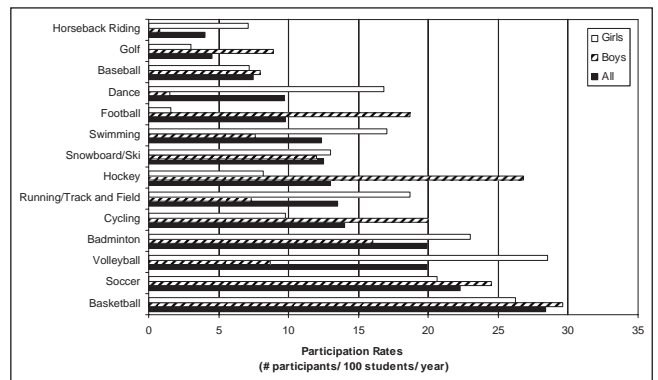


Figure 1) Sport-specific participation rates among Calgary and area (Alberta) junior high school students

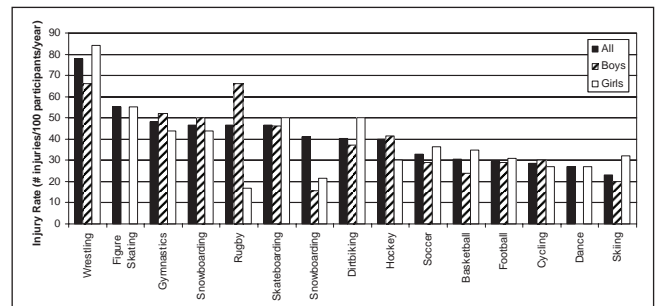


Figure 2) Sport-specific injury rates

A previous injury to the same body part was reported for 47% (95% CI 43.7% to 50.3%) of all injuries. Direct contact with another player or something else was the mechanism of injury reported for 68.9% (95% CI 65.8% to 72%) of injuries. Direct contact with another person was the mechanism of injury reported for 32% (95% CI 28.9% to 35.1%) of injuries. Of these, 39.3% (95% CI 33.6% to 45.2%) reported that the contact was not allowed within the rules of the sport. More than 70% of injuries reported in the top two contact sports for participation (ie, hockey, football) were related to direct contact. More than 40% of injuries reported in the top two noncontact sports for participation (ie, basketball, soccer) were related to direct contact. By sporting event type,

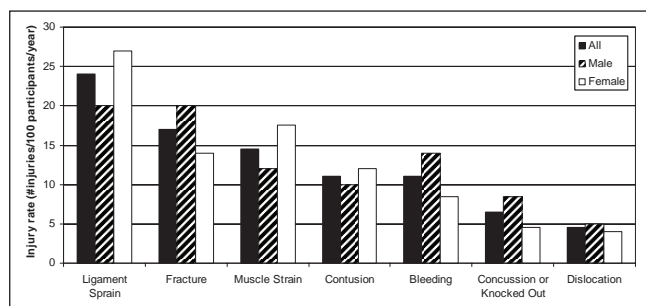


Figure 3) Proportion of most serious injuries by injury type and sex

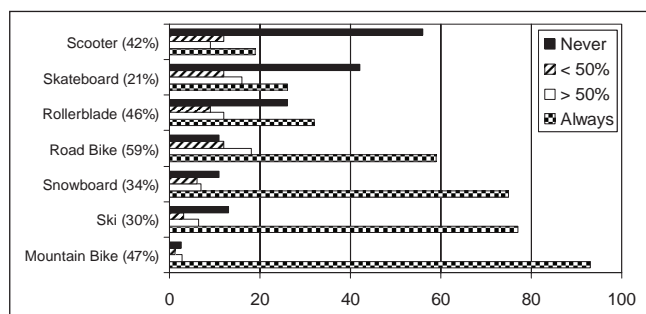


Figure 4) Proportion of participation and helmet use

39.3% of injuries reported occurred in a game, followed by recreational setting (26.9%), practice (19%) and physical education class (8.4%). The proportion of injuries by level of severity based on the reported time loss from sport were 32.5% slight (no time loss), 29.7% minimal/mild (one to seven days), 24.2% moderate (eight to 28 days), and 13.5% severe (longer than 28 days). Only 41.82% (95% CI 38.55% to 45.13%) of the injured adolescents reported receiving first aid treatment at the time of the injury.

Sport safety practices

The reported activity-specific use of helmets is summarized in Figure 4. The proportion of students participating in skateboarding, snowboarding and rollerblading that reported “never” wearing wrist guards was 74.2%, 75.8% and 46.1%, respectively. In the same activities, 4.7%, 7.1% and 18.2% reported “always” wearing wrist guards. The proportion of students who reported that they warm up in each of their top three chosen sports was 68.7%, 51.5% and 40.3%, respectively. The proportion of students who reported that they cool down in each of their top three chosen sports was 56.5%, 43.1% and 33.8%, respectively. Sixty-three per cent of adolescents indicated that they have learned about sport safety in the past 12 months. Of these, 68.2% indicated that they learned sport safety from a teacher, 51.1% from a parent and 40.9% from a coach.

Risk factors

The significant risk factors for injury based on multiple logistic regression analysis were amount of exposure to risk (average number of hours per week over one year) and the number of sports in which the student was coached (Table 2). There was no increased risk of injury by sex, age, ethnicity, BMI, level of mother’s or father’s education, residence location, stressful life events or other risk-taking behaviours (smoking, drinking or seatbelt use).

TABLE 2
Distribution of risk factors based on multiple logistic regression analysis adjusted for clustering by school

Injury	Adjusted OR	95% CI	P*
Weekly exposure, h/week			
<1	1.00		
1–2	1.87	1.34–2.61	<0.0001
>2–4	1.91	1.44–2.55	<0.0001
>4–7	2.28	1.6–3.24	<0.0001
>7–9	2.25	1.39–3.66	0.001
>9	2.26	1.57–3.27	<0.0001
Coaching			
None	1.00		
1 sport	1.82	1.39–2.38	<0.0001
2 sports	2.53	1.74–3.68	<0.0001
3 sports	2.65	1.82–3.87	<0.0001

*Statistical significance based on P≤0.05

DISCUSSION

Sport participation rates in youth are high. In our study, 70% of students surveyed participated in an organized sport and 64% participated for at least 1 h per week on average over the entire year. Thus, youth in Calgary and area appear to have a higher rate of participation in organized sports than the previously reported national rate of 43% participation in organized sports for at least once a week in the same age group (2).

The medically treated injury rate was consistent with the literature and lower in younger adolescents (aged 12 to 15 years) than previously found in older adolescents (aged 14 to 19 years) (7-10). It appears, however, that there was a slightly higher rate of injuries among younger adolescents presenting to hospital emergency departments (12.28 injuries/100 students/year) than among older adolescents (8.1 injuries/100 students/year) (10). This may reflect the parental influence on medical follow-up in younger compared with older adolescents. In a previous study (8) examining hospital-based sport injury rates in Canada based on data from 1994, there was an overall higher rate of injury estimated in the 15- to 19-year-old age group than the 10- to 14-year-old age group. This finding may reflect an increased participation and intensity of sport in this younger adolescent population since 1994.

The proportion of injuries reported was greatest in basketball, soccer, hockey and snowboarding/skiing. This is consistent with combined high rates of participation and injury found in these sports. Most of these sports involve a high rate of contact, jumping, sprinting and/or pivoting, which are often involved in the mechanism of injury in sports (13). The highest rates of injury were consistent for boys participating in hockey, basketball and football, and for girls participating in gymnastics, basketball and soccer (10,13). Other sports such as wrestling and rugby also had high injury rates. Injury prevention in these sports is also important; however, the public health significance is less because of lower participation rates (10,13).

There is some evidence that male adolescents are generally at greater risk for injury than female adolescents (OR 1.16 to 2.4) (16-19). The exception to this is in studies

(10,17,19-21) examining specific sports, including soccer and basketball (10,19), in which girls appear to be at greater risk. Consistent with other survey studies (10,22), we found no significant difference between overall injury rates in boys and girls. While some sport-specific injury rates in our study differed for boys and girls (Figure 2), injury rates in basketball and soccer were similar for boys and girls. This may reflect a different pattern of risk in a younger age group compared with that found in older adolescents. On examining injury type by sex, we found that boys were more likely to sustain concussions, fractures and bleeding injuries, and girls were more likely to sustain ligament sprains and muscle strains. This was consistent with findings in high school students (aged 14 to 19 years) (10). Hewett et al (23) and Emery et al (24) also demonstrated greater rates of knee sprain injury (including anterior cruciate ligament sprains) in adolescent female athletes. Consistent with other studies (10,15), ligament sprain was the most frequently occurring injury type, and ankle and knee were the most commonly injured body parts.

With 47% of injuries reported as re-injuries, the present study supports the evidence that previous injury is a significant risk factor for injury in sport. This highlights the importance of appropriate and sufficient age-specific sport physical therapy rehabilitation in the paediatric population (13,25). Consistent with high school students, direct contact with another person was the most common cause of injury in contact sports (ie, hockey and football), but also very common in noncontact sports (ie, basketball and soccer) (10).

Warm-up and cool-down practices were not standard practices in all reported sports, but they were, not surprisingly, more prevalent in the first chosen sport for participation than in the second and third chosen sports. Consistent with high school students, 63% indicated that they had learned about sport safety in the past year (10). The majority of students indicated that this education was directed by teachers (68.2%), followed by parents (51.1%) and coaches (40.9%). Thus, these individuals should be involved in evidenced-based and appropriate safety education tools that maximize sport safety education among young adolescents.

In 2003, legislation in the Province of Alberta mandated the use of helmets for road cyclists younger than 18 years of age. The effectiveness of this legislation appears to be greater in the younger population, in which close to 60% of adolescent road cyclists and more than 90% of mountain cyclists report using a helmet most of the time, compared with that found in high school students (less than 40% and less than 60%, respectively) (10). There is also a twofold greater use of helmets for snowboarding, rollerblading, skateboarding and scootering reported among junior high school students than among high school students (10). In both junior and senior high school students, 70% to 80% of students report that they never wear wrist guards for skateboarding and snowboarding (10). In rollerblading, however, 60% of high school students, compared with 46% of junior high school students, reported that they never wear wrist guards (10). The absence of protective equipment in sports will certainly increase the risk of

injury in some sports (26,27). Helmet use has been shown to be protective against head injury in snowboarding, skiing and cycling (26). There is also evidence to support the protective effect of wrist guards in snowboarding (27). Although some argue that the use of protective equipment may increase risk-taking behaviours in some sports, this has not been supported by research findings (28). The importance of promoting the use of protective equipment in youth sports is both evidence-based and critical.

Consistent with other studies (10,15), there is evidence to support an increased risk of injury with greater exposure to sport (ie, weekly hours) and to more competitive sports (ie, students reporting formal coaching). A negative association between socioeconomic status and all injury has been previously found (29,30). Pickett et al (11,31,32), however, found an increased risk of sport injury associated with increased socioeconomic status. Based on father's education alone, we did find a similar trend in our study based on point estimates. Our analysis was limited based on a lack of information regarding additional socioeconomic status indicators.

Pickett et al (32) found increased risk of all injury associated with risk-taking behaviours including smoking, drunkenness and nonuse of seatbelts. In our study examining sport injury alone, there was no apparent increased risk of injury associated with other risk-taking behaviours (ie, smoking, drinking and seat belt use). This relationship is not surprisingly stronger when including all injuries beyond sport-related injuries (ie, home, motor vehicle).

MacKay et al (33) and McGuine (34) suggest the evidence is weak for effective injury prevention strategies in youth sports. The majority of these studies (14,35) examined sport-specific training strategies in older adolescents (15 to 19 years) and demonstrated poor adoption (26% to 60%). This highlights the importance of future research focusing on the development and rigorous evaluation of sport injury prevention strategies targeting youth with a focus on maximizing adoption (ie, policy related to equipment use, neuromuscular training strategies).

Limitations

The accuracy of the information presented may be subject to bias because of the nature of the self-report survey techniques used. Limitations may include under-reporting of injury related to one-year recall. Sport participation rates in our study are also likely underestimated because students selected only their top three sports for participation. The time of year the survey was completed and the school location may have also influenced participants' selection of sports.

CONCLUSIONS

The present survey suggests that the majority of youth in grades 7 to 9 (aged 12 to 15 years) participate in sports. The rates of participation and rates of sport injury in this age group are high, although they are slightly lower among older adolescents. Although there is very little research evidence regarding the prevention of injuries in young adolescents (aged 12 to 15 years), the significant impact of

sport injury in this population warrants significant attention. Future research should focus on developing, implementing and evaluating injury prevention strategies in young adolescents.

Implications for prevention

The high rates of sport participation and sport injury in young adolescents have led to a significant public health impact. The present study identifies a clear need to target young adolescents with sport injury prevention strategies to maintain high rates of participation in physical activities, and to reduce the risk of early osteoarthritis and other future health concerns related to obesity and other diseases. Sport-specific populations and injuries are identified to target appropriate populations for future injury prevention research. An evaluation of global prevention strategies, including safety policies in sports, and school-based injury prevention strategies is critical to reducing the public health burden of sport injuries in youths.

ACKNOWLEDGEMENTS: Carolyn Emery is supported as a Canadian Institutes of Health Research New Investigator and an Alberta Heritage Foundation for Medical Research Population Health Investigator. The funding support for this research was through the Roger Jackson Centre for Health and Wellness Research and the Alberta Heritage Foundation for Medical Research. The authors acknowledge Jamie McInnis (research coordinator), the Calgary Public, Calgary Catholic, Rockyview, Foothills, and Christ the Redeemer School Boards, high school principals and participating teachers. Without their support, this research would not have been possible. The authors are especially grateful to the many junior high school students who consented to participate in this study.

DISCLOSURE: The authors have no competing interests to declare.

REFERENCES

- Canadian Fitness and Lifestyle Research Institute. 2004 Physical Activity Monitor. <<http://www.cflri.ca/eng/statistics/surveys/pam2004.php>> (Version current at April 25, 2007).
- Reconnecting Government with Youth Survey (2003). <<http://www.pch.gc.ca/pgm/sc/info-fact/youth-eng.cfm>> (Version current at August 14, 2009).
- Roos EW. Joint injury causes osteoarthritis in young adults. *Curr Opin Rheumatol* 2005;17:195-200.
- Drawer F, Fuller CW. Propensity for osteoarthritis and lower limb joint pain in retired professional soccer players. *Br J Sports Med* 2001;35:402-8.
- Blair SN, Kohl HW, Barlow CE, et al. Changes in physical fitness and all-cause mortality: A prospective study of healthy and unhealthy men. *JAMA* 1995;273:1093-8.
- Paffenbarger RS, Kamput JB, Lee IM, et al. Changes in physical fitness and other lifestyle patterns influence longevity. *Med Sci Sports Exerc* 1994;26:857-65.
- King MA, Pickett W, King AJC. Injury in Canadian youth: A secondary analysis of the 1993-94 Health Behaviour in School-Aged Children Survey. *Can J Public Health* 1998;89:397-401.
- Bienfeld M, Pickett W, Carr PA. A descriptive study of childhood injuries in Kingston, Ontario, using data from computerized injury surveillance system. *Chronic Dis Can* 1996;17:21-7.
- Mummery WK, Spence JC, Vincenten JA, et al. A descriptive epidemiology of sport and recreation injuries in a population-based sample: Results from the Alberta Sport and Recreation Injury Survey (ASRIS). *Can J Public Health* 1998;89:53-6.
- Emery CA, Meeuwisse WH, McAllister JR. A survey of sport participation, sport injury and sport safety practices in adolescents. *Clin J Sport Med* 2006;16:20-6.
- Pickett W, Molcho M, Simpson K, et al. Cross national study of injury and social determinants in adolescents. *Injury Prev* 2005;11:213-8.
- Grimmer KA, Jones D, Williams J. Prevalence of adolescent injury from recreational exercise: An Australian perspective. *J Adolesc Health* 2000;27:1-6.
- Emery C. Risk factors for injury in adolescent sport: A systematic review of the literature. *Clin J Sports Med* 2003;13:256-68.
- Emery CA, Rose MS, Meeuwisse WH, McAllister JR. The effectiveness of an injury prevention strategy in high school basketball. A Cluster-Randomized Controlled Trial. *Clin J Sport Med* 2007;17:17-24.
- Northern Sydney Area Health Services. New South Wales Youth Sports Injury Report. Sydney: Northern Sydney Area Health Service, 1997.
- Bijur PE, Trumble A, Harel Y, Overpeck MD, Jone D, Scheidt PC. Sports and recreation injuries in US children and adolescents. *Arch Pediatr Adolesc Med* 1995;149:1009-16.
- de Loes M. Epidemiology of sports injuries in the Swiss Organization Youth and Sports 1987-1989: Injuries, exposure and risks of main diagnoses. *Int J Sports Med* 1995;16:134-8.
- Lenaway DD, Ambler AG, Beaudoin DE. The epidemiology of school-related injuries: New perspectives. *Am J Prevent Med* 1992;8:193-8.
- Powell JW, Barber-Foss KD. Sex-related injury patterns among selected high school sports. *Am J Sports Med* 2000;28:385-91.
- Nilsson S, Roaas A. Soccer injuries in adolescents. *Am J Sports Med* 1978;6:358-61.
- Sullivan JA, Gross RH, Grana WA, Garcia-Moral CA. Evaluation of injuries in youth soccer. *Am J Sports Med* 1980;8:325-7.
- Nordstrom DL, Zwerling C, Stromquist AM, Burmeister LF, Merchant JA. Identification of risk factors for non-fatal child injury in a rural area: Keokuk County Rural Health Study. *Injury Prev* 2003;9:235-40.
- Hewett TE, Lindendorf TN, Riccobene JV, Noyes FR. The effect of neuromuscular training on the incidence of knee injury in female athletes. *Am J Sports Med* 1999;27:699-705.
- Emery CA, Meeuwisse WH, Hartmann S. Risk factors for injury in adolescent soccer: Implementation and validation of an injury surveillance system. *Am J Sports Med* 2005;33:1882-91.
- Lysens R, Steverlynck A, van den Auweele Y, et al. The predictability of sports injuries. *Sports Med* 1984;1:6-10.
- Hagel BE, Pless IB, Goulet C, Platt RW, Robitaille Y. Helmet effectiveness in skiers and snowboarders: Case-control and case-crossover study. *BMJ* 2005;330:281.
- Hagel BE, Pless IB, Goulet C. The effect of wrist guard use on upper-extremity injuries in snowboarders. *Am J Epidemiol* 2005;162:149-56.
- Hagel BE, Meeuwisse WH. Risk compensation: A "side effect" of sport injury prevention? *Clin J Sport Med* 2004;14:193-6.
- Faelker T, Pickett W, Brisson RJ. Socioeconomic differences in childhood injury: A population based epidemiologic study in Ontario, Canada. *Inj Prev* 2000;6:203-8.
- Engstrom K, Diderichsen F, Laflamme L. Socioeconomic differences in injury risks in childhood and adolescence: A nationwide study of intentional and unintentional injuries in Sweden. *Inj Prev* 2002;8:137-42.
- Pickett W, Garner MJ, Boyce WF, King MA. Gradients in risk for youth injury associated with multiple-risk behaviours: A study of 11,329 Canadian adolescents. *Soc Sci Med* 2002;55:1055-68.
- Pickett W, Dostaler S, Craig W, et al. Associations between risk behaviour and injury and the protective roles of social environments: An analysis of 7235 Canadian school children. *Inj Prev* 2006;12:87-92.
- MacKay M, Scanlan A, Olsen L. Sports and recreational injury prevention strategies: Systematic review and best practices: Executive summary. Vancouver, BC: BC Injury Research and Prevention Unit, 2001.
- McGuine T. Sports injuries in high school athletes: A review of injury-risk and injury-prevention research. *Clin J Sport Med* 2006;16:488-99.
- Myklebust G, Engebretsen L, Braekken IH, Skjollberg A, Olsen OE, Bahr R. Prevention of anterior cruciate ligament injuries in female team handball players: A prospective intervention study over three seasons. *Clin J Sport Med* 2003;13:71-8.