JOURNAL ARTICLE

Improving cycling safety for children and youth FREE

Daniel Rosenfield, B.Arts.Sc, MD, MHI, FRCPC,
Pamela Fuselli, BSc, BHA, MSc, Suzanne Beno, MD, FRCPC

Paediatrics & Child Health, Volume 29, Issue 5, August 2024, Pages 324–328, https://doi.org/10.1093/pch/pxae035
Published: 13 September 2024 **Article history** ▾

Abstract

Cycling remains a popular activity for children and youth around the world, combining the fun of moving at speed with numerous health and societal benefits. However, cycling is also associated with risk for serious injury and death. Over the past decade, research has increasingly shown that improving safety for cyclists depends, in large part, on the environment they are cycling in as well as on individual safety measures such as helmet use. The pandemic provided greater opportunity for many children and youth to engage in cycling, and refocused public attention on safer cycling infrastructure such as protected bike lanes. This statement reviews the evidence supporting safer cycling infrastructure for children and youth along with the physical and mental health benefits of cycling. The advantages of active transportation for young people, and how the built environment influences their cycling safety and uptake, are discussed. An overview of measures individuals can take to improve cycling safety is followed by recommendations for clinicians, the cycling community, parents, and policy-makers.

Issue Section: Position Statement/Document De Principes

BACKGROUND

Cycling is a popular activity around the globe. In Canada, many children and youth ride their bikes for pleasure, exercise, and getting

to and from school or other activities. However, cycling also poses risks for young people—injuries are common, and deaths can occur. Severe injuries and fatalities typically occur when cyclists are hit by motor vehicles. According to Canadian police-reported collision data, 513 children (aged 0–14 years) were seriously injured while cycling, and 4 were killed, in 2020 alone (1). Injury rates have trended downward since the early 2000s, however. In 2000, for example, 1592 child cyclists were injured, but annual injury numbers have stabilized since, with an average of 566 injuries per year from 2013 to 2020. Similarly, while an average of 14 child cyclists were killed each year between 2001 and 2004, the annual average was 4 deaths from 2005 to 2020. Mortality rates are just the tip of the iceberg, however. The number of children and youth who are affected by cycling-related injuries requiring hospitalization and causing chronic health issues remains significant. For example, cycling injuries were the third-leading cause of unintentional injury-related hospitalizations of children from 2006 to 2011 (2).

While cycling remains popular in Canada, overall cycling rates have decreased somewhat across all age groups. The most recent available data, from 2013 to 2014, showed that 24% of cyclists over 12 years of age reported cycling in the preceding 3 months, compared with 29% in 1994–1995 (3). There are multiple reasons for declining rates, but this statement focuses on the built environment, systems-level infrastructure, and more recent policy choices (4,5) as contributing factors.

Historically, cycling safety advocates have focused primarily on riders and their responsibilities, with emphasis on wearing a helmet and high-visibility clothing, following rules of the road, and bicycle maintenance as protective and preventive factors. However, research literature over the past decade has shown that while individual factors influence injury frequency and severity societal systems and choices also determine cycling uptake and safety. The built environment—how streets and neighbourhoods are designed, evolved, and used—plays a central role in keeping all cyclists, and especially children and youth, safer. This statement examines how clinicians, parents, and policy-makers can improve cycling safety for children, youth, and the broader community, by focusing on purpose-built infrastructure alongside strategies that optimize individual safety.

THE BENEFITS OF CYCLING

The health benefits of cycling during childhood are numerous and compelling, with physical fitness being the most robustly researched. Early exposure to and participation in physical activity, including cycling, helps establish positive routines lifelong. People who start cycling early often stay active throughout their adult lives (6), which lowers risk for developing cardiovascular disease, cancer, type 2 diabetes, and other, often chronic, conditions (7). A child's first 'commute' to school is a key opportunity to establish a healthy, active living pattern, perhaps for life (8). The evidence is clear that adult commuters who bike to work have a reduced risk of mortality from any cause, and specifically reduced risk of developing cardiovascular disease or cancer (7). Physical activity in children confers numerous health benefits, including mental health (9), which are discussed below.

ACTIVE TRANSPORTATION

Active transportation means getting somewhere using 'body power', with cycling and walking as common examples. Driving or busing are passive by contrast. Children and youth who get to and from school and other activities under their own steam experience significant benefits, including greater alertness at school and attention to their surroundings compared with their peers who are driven or bused (10). They are also in better physical shape and healthier over the longer term (7).

Despite increased vehicular use over the past 50 years and a steady decline in active transportation (11), the most recent available data suggest that one in three children continue to use active transportation to get to school (12). Multiple factors, including personal (e.g., age, gender, education), psychosocial (e.g., socioeconomic status [SES], perceptions of safety), and environmental (e.g., residential density, distance from school, neighbourhood connectivity) context, and local policies (e.g., school boundaries and busing distances) (13–15) also help determine transportation to and from school.

A recent, large cross-sectional study showed that active school transportation rates vary widely among large cities in Canada. In Quebec, for example, 40% of children used active transport to get to school in Laval, compared with 70% in Montreal. Within-city variation was even wider. In Montreal, the range was 0% to 96% across the city. The same study associated increased density of cycling infrastructure with higher rates of active transportation among children. Cycling infrastructure effects were the largest in Toronto, Montreal, and Laval, with smaller effects found in other Canadian cities (13). Research on the built environment tends to focus on urban areas with significant density. No studies exploring the use of cycling infrastructure in rural or remote areas of Canada were found.

THE BUILT ENVIRONMENT

The term “built environment” refers to any human-made area or infrastructure and encompasses land use patterns, streets, sidewalks, and other transportation-related amenities. Rising obesity rates have sharpened the attention of public health policy-makers and community advocates on the role of built environment toward ensuring walkability and cycling capacity within neighbourhoods. Strong correlations exist among obesity rates, SES, and the built environment, such that low walkability scores and lack of cycling infrastructure correlate with increased obesity rates (16,17). When considering health equity, it is well recognized that the lowest cycling rates are seen in low-income, immigrant, and racialized populations (18). A leading reason why is the poor cycling infrastructure often found in disadvantaged neighbourhoods (19,20).

Recent studies conducted both in Canada and elsewhere have shown that pedestrian and cyclist safety are closely related to the built environment. Land use and zoning policies play a defining role in cyclist safety. Denser, mixed-use communities lead to shorter trip lengths with concordantly higher cycling rates. When examining cycling-specific infrastructure, one 2020 study showed that increasing the number and connectedness of “cycle tracks” (i.e., dedicated bike lanes) in Toronto improved safety for cyclists significantly (12). Not only were cyclists more protected in these lanes, but a “halo” effect was also observed: a significant reduction

in collisions involving motorists and pedestrians in the 500 m area surrounding these cycle tracks also occurred (21). In 2021, another Toronto-based study by the same researchers found that when a large proportion of drivers exceeded the posted speed limit in front of elementary schools, this behaviour correlated with decreased rates of active transportation among children and youth (22).

The fact that dedicated cycling lanes decrease injuries has been well established in the literature. One 2013 Cochrane review showed a 50% decrease in collisions involving children in one town when protected bike lanes were built, compared with a comparable town that did not have them (23). While a variety of bike lane configurations exist (e.g., painted on established roads, protected right of ways, or elevated lanes), one recent study by the Insurance Institute for Highway Safety found that elevated, protected bike lanes were safest (24). Protected lanes and infrastructure have also been shown to increase the number of cyclists overall (25). Data from one international study highlighted that rates of female cyclists closely match those of children. Women generally cycle most frequently when and where there is protective cycling infrastructure (26).

Conditions that support safer cycling infrastructure also help to safeguard other outdoor activities for children, specifically by making it safer for them to walk within neighbourhoods. Because walking is the primary active transportation method used by children to get to school, factors besides dedicated cycling infrastructure that increase access and safety, such as crossing guards and traffic signals, are worth noting (13).

Parental perceptions of the local built environment also have a role in determining children's physical activity levels, including outdoor play, cycling, and active transportation to school. Where parents perceive higher risk, their children's physical activity levels decrease. Safer environments are associated with more physical activity by children. Designing infrastructure that encourages active transportation will help reassure parents and lead them to relax restrictions around children's free play, cycling, walking, and other healthy activities (27).

The speed of motorized vehicles is directly associated with the risk and severity of collisions. Traffic calming interventions such as

speed humps, speed limits, and speed cameras have been shown to effectively reduce speeding, collision, and injury rates (28–30). Other measures include narrowing streets, curb extensions, driver feedback signs, on-street parking, and raised intersections (31). Such interventions have been shown to improve local perceptions of safety, a correlate of active transportation uptake. Exceptionally, however, any intervention that narrows total available road space and brings cyclists closer to vehicular traffic (compared with narrowing vehicle lanes to increase space for cyclists) often has the opposite effect (32).

The differences between rural versus urban built environments are worth considering, especially as they affect cycling and the active transportation of children to school. Canadian data have shown that built environments in rural areas are generally less favourable to cycling compared with larger Canadian cities, but much more research conducted in a variety of Canadian settings is needed (33).

THE COST-EFFECTIVENESS OF CYCLING INFRASTRUCTURE

Recent economic analyses have confirmed that investing in cycling infrastructure is cost-effective, with public health benefits that consistently outweigh the rising costs of building infrastructure (34,35). One 2021 study estimated that investment in infrastructure which led to a modest 2% increase in bike use would bring economic benefits worth $116.6 million in Victoria, B.C. and $59.1 million in Halifax, N.S., a benefit:cost ratio of 1.7:1 and 2.1:1, respectively (34). Local pushback to expanding protected cycle tracks can sometimes speak over the benefits. However, most recent analyses have demonstrated that fears concerning the removal of parking spaces and vehicular custom for curb-side businesses are not borne out. For example, when Toronto installed dedicated cycle tracks on Bloor Street (a main east-west artery through the heart of the city), businesses experienced an increase in both customers and revenue, not a decrease (36).

VISION ZERO

Vision Zero is a broad-based strategy to eliminate traffic fatalities and severe injuries completely, with principles that apply to nearly all cycling environments. Initiated by the government of Sweden in 1997, it has been adopted by many others around the world since. In 2017, the European Academy of Paediatrics urged policy-makers to work toward a continent where no child is killed in traffic (37). Vision Zero combines smart road design, overall system planning, and public policies to improve individual safety. Vision Zero is also being adopted across Canada, with 19 cities and 2 regions from 7 provinces participating. Canada's largest cities have all signed on, and British Columbia and Manitoba have adopted Vision Zero at the provincial level (38). While jurisdictions have prioritized different aspects of the strategy and budgets vary, all are committed to its key principles.

CYCLING DURING AND AFTER THE PANDEMIC

An unanticipated social effect of the COVID-19 pandemic was that outdoor physical activity increased for certain populations, most consistently among higher SES householders (39). Both in Canada and around the world, cycling rates rose dramatically (40,41), and while cycling-related injuries increased, most were not severe (42). Many cities around the world experimented with, then mandated, permanent cycling infrastructure. In Canada, clear pathways toward implementation are needed to prevent paediatric injury rates from increasing.

INDIVIDUAL ACTIONS

Although systems-level infrastructure and built environments are the primary determinants of cycling safety, injury prevention programs and family counselling also have roles. Approximately one-half of children who are admitted to hospital with a cycling-related injury have sustained a severe head injury, and head injuries also represent between 45% and 100% of injuries causing death (43).

The literature is unequivocal that helmet use reduces both the number and severity of head injuries significantly (44). Two Cochrane systematic reviews demonstrated that helmets reduce the risk of head and brain injuries by 69%, severe brain injuries by 74%, and facial injuries by 65% across all age groups (45,46). A 2018 meta-analysis confirmed these findings, noting a 48% reduction in total head injuries, a 60% reduction in serious head injuries, a 23% reduction in facial injuries, and a reduction in the total number of killed or seriously injured cyclists by 34% (47).

The challenges of increasing helmet use in the paediatric population persist, however. The literature has shown that helmet legislation is not only the most powerful lever that policy-makers have to protect young people (48), but these laws do not discourage or decrease the number of children cycling in jurisdictions where they are passed (49). Consistently however, the rates of bicycle ridership and helmet use among young people in Canada have been associated most strongly with higher SES (50,51). There is also an urban versus rural divide, whereby children in rural environments use helmets less than their urban peers (51,52).

Other safety equipment (e.g., wrist guards) have fewer clear benefits. One 2005 study found that wrist guards impeded children's ability to cycle comfortably and may have limited utility for protecting against injuries sustained during a fall (53).

Training children to anticipate risks and hazards also has challenges. One study found that while young children who participated in safety programs were able to identify dangerous situations better than peers without such training, this awareness did not change their safety behaviours significantly (54). Many cyclist education programs exist for children in Canada and worldwide, but their effectiveness remains largely unknown because evaluation mechanisms and follow-up have been weak or lacking altogether (55).

RECOMMENDATIONS

The pandemic helped renew public focus on cycling by children and youth as a physical activity to encourage and build for in Canada. The onus of cycling-related injury prevention has shifted somewhat

from the individuals engaged in this activity toward the built environment. Local governments must be informed of options that build, expand, and promote safer cycling infrastructure. They must also invest in redevelopment.

With families they see, health care professionals should promote active transportation for children and youth to and from school and advocate for policies that support safer cycling and walking in their communities.

The Canadian Paediatric Society supports safe, active, and equitable cycling for children and youth through enhancing and optimizing the built environment as follows:

- Install more protected (and ideally, elevated) bike lanes that physically separate cyclists from motorized traffic, and make existing pilot lanes permanent. Focus should be on and around areas of high use by children and youth, especially near schools, community centres, and recreation and play spaces.
- Deploy more speed and red-light cameras in high-traffic areas near schools, busy neighbourhoods, and recreation and play spaces.
- Implement traffic calming measures where children and youth live, play, and travel to and from school.
- Adopt ‘Vision Zero’ interventions that increase road safety for all users.
- Increase helmet use among children and youth through education, legislation, and training programs (with evaluation and follow-up). Mandatory helmet legislation should exist across all provinces and territories and, ideally, for all ages.
- Target research and advocacy to increase cycling, road safety, and helmet use in rural and remote areas of Canada.

CANADIAN PAEDIATRIC SOCIETY INJURY PREVENTION COMMITTEE (March 2023)

Members:*Dominic Allain FRCPC MD, Émilie Beaulieu MD MPH, Suzanne Beno MD (Chair), Jeff Critch MD (Board Representative), Kristian Goulet MD, Daniel Rosenfield MD, Maaz Mirza (Resident Member)*

Liaisons:*Andre Champagne (Public Health Agency of Canada), Pamela Fuselli (Parachute—Leaders in Injury Prevention), April Kam MD (CPS Paediatric Emergency Medicine Section)*

Principal authors:*Daniel Rosenfield B.Arts.Sc, MD, MHI, FRCPC, Pamela Fuselli BSc, BHA, MSc, Suzanne Beno MD FRCPC*

Acknowledgement

The authors wish to thank Adam Rosenfield and Stephanie Cowle for their expert review. This position statement was reviewed by the Adolescent Health and Community Paediatrics Committees of the Canadian Paediatric Society, as well as by representatives of the Public Health Agency of Canada's Behaviours, Environments and Lifespan Division.

Funding

No funding to report.

Potential Conflicts of Interest

All authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Transport Canada. National Collision Database Online 1.0. 2021. https://open.canada.ca/data/en/dataset/1eb9eba7-71d1-4b30-9fb1-30cbdab7e63a (Accessed October 16, 2023).

2. Parachute. Unintentional Injury Trends for Canadian Children (Key messages and Figure 4). June 2016. https://parachute.ca/wp-content/uploads/2019/06/SKW-Trend-Report.pdf (Accessed October 16, 2023).
3. Ramage-Morin PL; Statistics Canada. Cycling in Canada. Health Reports 28. April 19, 2017 (archived content). https://www150.statcan.gc.ca/n1/pub/82-003-x/2017004/article/14788-eng.htm (Accessed October 16, 2023).
4. Canadian Automobile Association (CAA). Lack of Proper Infrastructure a Key Barrier to Canadians Cycling More, CAA Finds. July 28, 2020. https://www.caa.ca/news/lack-of-proper-infrastructure-a-key-barrier-to-canadians-cycling-more-caa-finds/#:~:text=Smart%20Infrastructure-,Lack%20of%20proper%20infrastructure%20a%20key,Canadians%20cycling%20more%2C%20CAA%20finds&text=Nearly%20one%20in%20three%20Canadians,Association%20(CAA)%20released%20today (Accessed September 25, 2023).
5. Pucher J, Buehler R. Sustainable transport in Canadian cities: Cycling trends and policies. *Berkeley Plan J* 2006;19(1):97–123. doi:10.5070/bp319111491
Google Scholar WorldCat
6. Telama R, Yang X, Viikari J, Välimäki I, Wanne O, Raitakari O. Physical activity from childhood to adulthood: A 21-year tracking study. *Am J Prev Med* 2005;28(3):267–73. doi:10.1016/j.amepre.2004.12.003
Google Scholar Crossref PubMed WorldCat
7. Celis-Morales CA, Lyall DM, Welsh P, et al. Association between active commuting and incident cardiovascular disease, cancer, and mortality: Prospective cohort study. *BMJ* 2017;357:j1456. doi:10.1136/bmj.j1456
Google Scholar PubMed WorldCat
8. DeWeese RS, Acciai F, Tulloch D, Lloyd K, Yedidia MJ, Ohri-Vachaspati P. Active commuting to school: A longitudinal analysis examining persistence of behavior over time in four New Jersey cities. *Prev Med Rep* 2022;26:101718. doi:10.1016/j.pmedr.2022.101718
Google Scholar Crossref PubMed WorldCat
9. Ahn S, Fedewa AL. A meta-analysis of the relationship between children's physical activity and mental health. *J Pediatr Psychol* 2011;36(4):385–97. doi:10.1093/jpepsy/jsq107
Google Scholar Crossref PubMed WorldCat

10. Westman J, Johansson M, Olsson LE, Mårtensson F, Friman M. Children's affective experience of every-day travel. *J Transport Geogr* 2013;29:95–102. doi:10.1016/j.jtrangeo.2013.01.003
Google Scholar Crossref WorldCat

11. McDonald NC, Brown AL, Marchetti LM, Pedroso MS. U.S. school travel, 2009: An assessment of trends. *Am J Prev Med* 2011;41(2):146–51. doi:10.1016/j.amepre.2011.04.006
Google Scholar Crossref PubMed WorldCat

12. Pabayo R, Gauvin L, Barnett TA. Longitudinal changes in active transportation to school in Canadian youth aged 6 through 16 years. *Pediatrics* 2011;128(2):e404–13. doi:10.1542/peds.2010-1612
Google Scholar Crossref PubMed WorldCat

13. Rothman L, Hagel B, Howard A, et al. Active school transportation and the built environment across Canadian cities: Findings from the child active transportation safety and the environment (CHASE) study. *Prev Med* 2021;146:106470. doi:10.1016/j.ypmed.2021.106470
Google Scholar Crossref PubMed WorldCat

14. Buttazzoni AN, Coen SE, Gilliland JA. Supporting active school travel: A qualitative analysis of implementing a regional safe routes to school program. *Soc Sci Med* 2018;212:181–90. doi:10.1016/j.socscimed.2018.07.032
Google Scholar Crossref PubMed WorldCat

15. Buttazzoni AN, Clark AF, Seabrook JA, Gilliland JA. Promoting active school travel in elementary schools: A regional case study of the school travel planning intervention. *J Transport Health* 2019;12:206–19. doi:10.1016/j.jth.2019.01.007
Google Scholar Crossref WorldCat

16. Malacarne D, Handakas E, Robinson O, et al. The built environment as determinant of childhood obesity: A systematic literature review. *Obes Rev* 2022;23(Suppl 1):e13385. doi:10.1111/obr.13385
Google Scholar PubMed WorldCat

17. Pan X, Zhao L, Luo J, et al. Access to bike lanes and childhood obesity: A systematic review and meta-analysis. *Obes Rev* 2021;22(Suppl 1):e13042. doi:10.1111/obr.13042
Google Scholar PubMed WorldCat

18. Vidal Tortosa E, Lovelace R, Heinen E, Mann RP. Cycling behaviour and socioeconomic disadvantage: An investigation based on the English National Travel Survey. *Transp Res Part A: Policy Pract* 2021;152:173–85. doi:10.1016/j.tra.2021.08.004
Google Scholar WorldCat

19. Flanagan E, Lachapelle U, El-Geneidy A. Riding tandem: Does cycling infrastructure investment mirror gentrification and privilege in Portland, OR and Chicago, IL? *Res Transp Econ* 2016;60:14–24. doi:10.1016/j.retrec.2016.07.027
Google Scholar Crossref WorldCat

20. Goddard T, Kahn KB, Adkins A. Racial bias in driver yielding behavior at crosswalks. *Transp Res Part F: Traffic Psychol Behav* 2015;33:1–6. doi:10.1016/j.trf.2015.06.002
Google Scholar Crossref WorldCat

21. Ling R, Rothman L, Cloutier MS, Macarthur C, Howard A. Cyclist-motor vehicle collisions before and after implementation of cycle tracks in Toronto, Canada. *Accid Anal Prev* 2020;135:105360. doi:10.1016/j.aap.2019.105360
Google Scholar Crossref PubMed WorldCat

22. Ling R, Rothman L, Hagel B, et al. The relationship between motor vehicle speed and active school transportation at elementary schools in Calgary and Toronto, Canada. *J Transp Health* 2021;21:101034. doi:10.1016/j.jth.2021.101034
Google Scholar Crossref WorldCat

23. Mulvaney CA, Smith S, Watson MC, et al. Cycling infrastructure for reducing cycling injuries in cyclists. *Cochrane Database Syst Rev* 2015;2015(12):CD010415. doi:10.1002/14651858.CD010415.pub2
Google Scholar PubMed WorldCat

24. Cicchino JB, McCarthy ML, Newgard CD, et al. Not all protected bike lanes are the same: Infrastructure and risk of cyclist collisions and falls leading to emergency department visits in three U.S. cities. *Accid Anal Prev* 2020;141:105490. doi:10.1016/j.aap.2020.105490
Google Scholar Crossref PubMed WorldCat

25. Larouche R. Built environment features that promote cycling in school-aged children. *Curr Obes Rep* 2015;4(4):494–503. doi:10.1007/s13679-015-0181-8
Google Scholar Crossref PubMed WorldCat

26. Goel R, Goodman A, Aldred R, et al. Cycling behaviour in 17 countries across 6 continents: Levels of cycling, who cycles, for what purpose, and how far? *Transp Rev* 2022;42(1):58–81. doi:10.1080/01441647.2021.1915898
Google Scholar Crossref WorldCat

27. Carver A, Timperio A, Crawford D. Perceptions of neighborhood safety and physical activity among youth: The CLAN study. *J Phys Act Health* 2008;5(3):430–44. doi:10.1123/jpah.5.3.430
Google Scholar Crossref PubMed WorldCat

28. Rothman L, Macpherson A, Buliung R, et al. Installation of speed humps and pedestrian-motor vehicle collisions in Toronto, Canada: A quasi-experimental study. *BMC Public Health* 2015;15:774. doi:10.1186/s12889-015-2116-4
Google Scholar Crossref PubMed WorldCat

29. Islam MT, El-Basyouny K. An integrated speed management plan to reduce vehicle speeds in residential areas: Implementation and evaluation of the Silverberry Action Plan. *J Safety Res* 2013;45:85–93. doi:10.1016/j.jsr.2013.01.010
Google Scholar Crossref PubMed WorldCat

30. Wilson C, Willis C, Hendrikz JK, Bellamy N. Speed enforcement detection devices for preventing road traffic injuries. *Cochrane Database Syst Rev* 2006(2):CD004607. doi:10.1002/14651858.CD004607.pub2
Google Scholar WorldCat

31. Fabri E, Thomas M; Human Environments Analysis Laborator, Western University. Investigation of Supportive Policy for Active School Travel: Evidence-based recommendations for policies to promote active transportation of school journeys. 2022. https://ontarioactiveschooltravel.ca/wp-content/uploads/2022/08/Supportive-Policy-Report-AST-2022.pdf (Accessed September 26, 2023).

32. Bellefleur O, Gagnon F; National Collaborating Centre of Health Public Policy. Urban traffic calming and health: Literature review. Quebec City: Government of Quebec; 2012: https://www.ncchpp.ca/docs/ReviewLiteratureTrafficCalming_En.pdf (Accessed September 26, 2023).

33. O'Loghlen S, Pickett JW, Janssen I. Active transportation environments surrounding Canadian schools. *Can J Public Health* 2011;102(5):364–8. doi:10.1007/BF03404178
Google Scholar Crossref PubMed WorldCat

34. Whitehurst DGT, DeVries DN, Fuller D, Winters M. An economic analysis of the health-related benefits associated with bicycle infrastructure investment in three Canadian cities. *PLoS One* 2021;16(2):e0246419. doi:10.1371/journal.pone.0246419
Google Scholar Crossref PubMed WorldCat

35. Brown V, Diomedi BZ, Moodie M, Veerman JL, Carter R. A systematic review of economic analyses of active transport interventions that include physical activity benefits. *Transp Policy* 2016;45:190–208. doi:10.1016/j.tranpol.2015.10.003
Google Scholar Crossref WorldCat

36. Arancibia D, Farber S, Savan B, et al. Measuring the local economic impacts of replacing on-street parking with bike lanes: A Toronto (Canada) study. *J Am Plan Assoc* 2019;85(4):463–81. doi:10.1080/01944363.2019.1638816
Google Scholar Crossref WorldCat

37. Ludvigsson JF, Stiris T, Del Torso S, Mercier JC, Valiulis A, Hadjipanayis A. European Academy of Paediatrics Statement: Vision zero for child deaths in traffic accidents. *Eur J Pediatr* 2017;176(2):291–2. doi:10.1007/s00431-016-2836-1
Google Scholar Crossref PubMed WorldCat

38. Parachute, Vision Zero. Parachute Vision Zero Canadian Landscape 3.0. 2022;12. https://www.parachute.ca/wp-content/uploads/2022/06/CS12-Landscape-3.0-VZ-UA.pdf (Accessed September 26, 2023).

39. Mitra R, Moore SA, Gillespie M, et al. Healthy movement behaviours in children and youth during the COVID-19 pandemic: Exploring the role of the neighbourhood environment. *Health Place* 2020;65:102418. doi:10.1016/j.healthplace.2020.102418
Google Scholar Crossref PubMed WorldCat

40. Buehler R, Pucher J. Cycling through the COVID-19 pandemic to a more sustainable transport future: Evidence from case studies of 14 large bicycle-friendly cities in Europe and North America. *Sustainability* 2022;14(12):7293. doi:10.3390/su14127293
Google Scholar Crossref WorldCat

41. Moore SA, Faulkner G, Rhodes RE, et al. Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: A national survey. *Int J Behav Nutr Phys Act* 2020;17(1):85. doi:10.1186/s12966-020-00987-8
Google Scholar Crossref PubMed WorldCat

42. Shack M, Davis AL, Wj Zhang E, Rosenfield D. Bicycle injuries presenting to the emergency department during COVID-19 lockdown. *J Paediatr Child Health* 2022;58(4):600–3. doi:10.1111/jpc.15775
Google Scholar Crossref PubMed WorldCat

43. Michael PD, Davenport DL, Draus JM. Bicycle helmets save more than heads: Experience from a pediatric level I trauma hospital. *Am Surg* 2017;83(9):1007–11. doi:10.1177/000313481708300939
Google Scholar Crossref PubMed WorldCat

44. Hagel BE, Yanchar NL; Injury Prevention Committee. Bicycle helmet use in Canada: The need for legislation to reduce the risk of head injury. *Paediatr Child Health* 2013;18(9):475–80. https://cps.ca/en/documents/position/bike-helmets-to-reduce-risk-of-head-injury
Google Scholar Crossref WorldCat

45. Macpherson A, Spinks A. Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. *Cochrane Database Syst Rev* 2008;2008(3):CD005401. doi:10.1002/14651858.CD005401.pub3
Google Scholar PubMed WorldCat

46. Thompson DC, Rivara FP, Thompson R. Helmets for preventing head and facial injuries in bicyclists. *Cochrane Database Syst Rev* 2000;1000(2):CD001855. doi:10.1002/14651858.CD001855
Google Scholar WorldCat

47. Høye A. Bicycle helmets—To wear or not to wear? A meta-analyses of the effects of bicycle helmets on injuries. *Accid Anal Prev* 2018;117:85–97. doi:10.1016/j.aap.2018.03.026
Google Scholar Crossref PubMed WorldCat

48. Lohse JL. A bicycle safety education program for parents of young children. *J Sch Nurs* 2003;19(2):100–10. doi:10.1177/10598405030190020701
Google Scholar Crossref PubMed WorldCat

49. Dennis J, Potter B, Ramsay T, Zarychanski R. The effects of provincial bicycle helmet legislation on helmet use and bicycle ridership in Canada. *Inj Prev* 2010;16(4):219–24. doi:10.1136/ip.2009.025353
Google Scholar Crossref PubMed WorldCat

50. Gulack BC, Englum BR, Rialon KL, et al. Inequalities in the use of helmets by race and payer status among pediatric cyclists. *Surgery* 2015;158(2):556–61. doi:10.1016/j.surg.2015.02.025
Google Scholar Crossref PubMed WorldCat

51. Davison CM, Torunian M, Walsh P, Thompson W, McFaull S, Pickett W. Bicycle helmet use and bicycling-related injury among young Canadians: An equity analysis. *Int J Equity Health* 2013;12:48. doi:10.1186/1475-9276-12-48
Google Scholar Crossref PubMed WorldCat

52. Embree TE, Romanow NTR, Djeroua MS, Morgunov NJ, Bourdeaux JJ, Hagel BE. Risk factors for bicycling injuries in children and adolescents: A systematic review. *Pediatrics* 2016;138(5):e20160282. doi:10.1542/peds.2016-0282
Google Scholar Crossref PubMed WorldCat

53. Cassell E, Ashby K, Gunatilaka A, Clapperton A. Do wrist guards have the potential to protect against wrist injuries in bicycling, micro scooter riding, and monkey bar play? *Inj Prev* 2005;11(4):200–3. doi:10.1136/ip.2004.006411
Google Scholar Crossref PubMed WorldCat

54. Zeuwts L, Ducheyne F, Vansteenkiste P, D'Hondt E, Cardon G, Lenoir M. Associations between cycling skill, general motor competence and body mass index in 9-year-old children. *Ergonomics* 2015;58(1):160–71. doi:10.1080/00140139.2014.961971
Google Scholar PubMed WorldCat

55. Hamann CJ, Conrad A. Inventory of child bicycle education programs reveals need for age, development, and skill-level considerations. *Traffic Inj Prev* 2019;20(sup3):33–8. doi:10.1080/15389588.2019.1665651.
Google Scholar Crossref PubMed WorldCat

© Canadian Paediatric Society 2024. Published by Oxford University Press on behalf of the Canadian Paediatric Society. All rights reserved. For commercial re-use, please contact reprints@oup.com for reprints and translation rights for reprints. All other permissions can be obtained through our RightsLink service via the Permissions link on the article page on our site—for further information please contact journals.permissions@oup.com.

This article is published and distributed under the terms of the Oxford University Press, Standard Journals Publication Model (https://academic.oup.com/pages/standard-publication-reuse-rights)