

Measuring Active Transportation on National Health Surveys in Canada From 1994 to 2020

Parya Borhani,¹ Kathryn L. Walker,² Gregory P. Butler,¹ Valérie Lavergne,¹ Gisèle Contreras,¹ and Stephanie A. Prince^{1,3}

¹Center for Surveillance and Applied Research, Public Health Agency of Canada, Ottawa, ON, Canada; ²Population Health PhD Program, University of Ottawa, Ottawa, ON, Canada; ³School of Epidemiology and Public Health, Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada

Background: Active transportation (AT), described as self-powered modes of travel (eg, walking and cycling), is an important source of health-promoting physical activity. While AT behaviors have been measured on national health surveys in Canada for over 2 decades, historic prevalence has not been previously reported. We aimed to document the measures of AT on Canada's various national health surveys, examine AT over time, and interpret them within the context of evolving methods of assessment. **Methods:** We compiled and summarized the questions used to measure AT among Canadians on 4 national health surveys: National Population Health Survey (1994–1998), Canadian Community Health Survey (2000–2020), Canadian Health Measures Survey (2007–2019), and the Health Behaviour in School-aged Children Study (2010–2018). Among youth and adults (12+ y), we summarized over time: (1) the prevalence of AT participation and (2) time spent in AT (in hours per week) among those who report any AT participation. Where possible, we reported separate estimates of walking and cycling and produced an aggregate estimate of total AT. We stratified results by age group and sex. **Results:** Changes in AT survey questions over time and between surveys limit the interpretation and comparability of temporal trends. Nevertheless, a consistently higher proportion of females report walking, while a higher proportion of males report cycling. Irrespective of mode, males report spending more total time in AT. Participation in AT tends to decrease with age, with youth reporting the highest rates of AT and young adults often spending the most time in AT. **Conclusions:** Monitoring trends in AT can help assess patterns of behavior and identify whether promotion strategies are needed or whether population interventions are effective. Our evaluation of AT over time is limited by questions surveyed; however, consistent differences in AT by age and sex are evident over time. Moving forward, ensuring consistency of AT measurement over time is essential to monitoring this important behavior.

Keywords: surveillance, measurement, population health, motor activity, walking, cycling

Background

Active transportation (AT), which can be defined as using nonmotorized, active ways (eg, walking, cycling, and rollerblading) to move from one place to another, is an important source of moderate- to vigorous-intensity physical activity across the life course and a means of meeting physical activity recommendations.¹ AT has social and economic benefits conferred through mechanisms such as de-carbonization, reduced health care costs,

and increased productivity,²⁻⁴ and is associated with health benefits including lower incident risk of cancer, cardiovascular disease, all-cause mortality, and improved psychological well-being.⁵⁻⁸ Typically, cycling for AT confers greater health benefits, resulting from the increased intensity of exercise associated with cycling versus walking and greater duration of activity.^{7,9,10} With the global and Canadian health concern of physical inactivity,¹¹ promoting AT can have public health benefits.

AT is one of 4 domains of physical activity,¹² and individuals can participate in AT for a relatively low cost.¹³ To promote physical activity and AT use, the World Health Organization has recommended the creation of AT supportive environments.^{11,14} In Canada, the Chief Public Health Officer of Canada has also highlighted the importance of AT for health.¹⁵ High-quality surveillance measures are needed to monitor AT rates and to measure progress in increasing participation in AT. This is a particularly timely matter in Canada, in light of the federal government's commitment to deploy \$400 million from 2021 to 2026 to facilitate the creation and expansion of AT infrastructure across the country.¹⁶

AT surveillance studies have been conducted in many countries, though few have examined results across multiple surveillance systems or disaggregated results by key demographics such as sex or age.¹⁷⁻²⁰ In Canada, there has been limited work exploring changes in AT with most previous work having focused on AT to work and specifically cycling.²¹⁻²³ There remains a gap in our understanding of how AT in general and mode-specific AT

© 2024 The Authors. Published by Human Kinetics, Inc. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, CC BY-NC 4.0, which permits the copy and redistribution in any medium or format, provided it is not used for commercial purposes, the original work is properly cited, the new use includes a link to the license, and any changes are indicated. See <http://creativecommons.org/licenses/by-nc/4.0>. This license does not cover any third-party material that may appear with permission in the article. For commercial use, permission should be requested from Human Kinetics, Inc., through the Copyright Clearance Center (<http://www.copyright.com>).


Borhani  <https://orcid.org/0009-0007-6260-2102>

Walker  <https://orcid.org/0009-0004-4259-6321>

Butler  <https://orcid.org/0000-0002-7536-2044>

Lavergne  <https://orcid.org/0009-0001-2942-8452>

Contreras  <https://orcid.org/0000-0003-2788-1533>

Prince (stephanie.prince.ware@phac-aspc.gc.ca) is corresponding author,  <https://orcid.org/0000-0001-6729-5649>

(eg, walking and cycling separated) has changed over time in Canada. Several nationally representative health surveys have collected AT-specific data over time. These estimates have not previously been reported together. Therefore, the objectives of this study were: (1) to compile the questions used to measure AT on national health surveillance surveys in Canada, (2) to examine national prevalence in AT among Canadians as measured on different national health surveys and questions overall and by age and sex, and (3) to understand the impact of question changes on AT estimates.

Methods

An environmental scan of all national health surveys in Canada was carried out to describe and document measures of AT on Canadian national health surveys, and report on AT prevalence over time and across the surveys. Briefly, academic databases and grey literature were searched. The following academic databases were searched: Medline, Embase, TRID, Web of Science, CINAHL, SPORTDiscus, ProQuest Dissertations and Theses, and Sociological Abstracts. The grey literature search was completed by searching Google and contacting Statistics Canada and the Carleton, Ottawa, Outaouais Research Data Centre (COOL-RDC). Results were limited to active health surveys. Where possible, walking for AT was reported separately from cycling for AT.

Study Population

We assessed AT behaviors in Canadian youth and adults (aged 12+ y) as measured through Canada's population health surveys. We further divided respondents into 12–17 years (youth), 18–34 years, 35–49 years, 50–64 years, 65–79 years, and 80+ years for age-stratified analyses.

Data Sources

We used data from 4 national, cross-sectional population health surveys covering the years from 1994 to 2020. The included surveys were: (1) National Population Health Survey (NPHS, 1994–1999), (2) Canadian Community Health Survey (CCHS, 2000–2020), (3) Canadian Health Measures Survey (CHMS, 2007–2019), and (4) Health Behavior in School-aged Children Study (HBSC, 2010–2018).

National Population Health Survey

The NPHS was a longitudinal health survey active from 1994 to 2011 conducted every 2 years. The target population of the NPHS included household residents of all ages (0+ y) living in any of the 10 provinces. We used data from the household component of the first 3 cycles of the survey (1994–95, 1996–97, and 1998–99), as these cycles provided cross-sectional national prevalence data.²⁴

Canadian Community Health Survey

The CCHS is an ongoing cross-sectional health survey conducted annually that began in 2000 as a continuation of the cross-sectional component of the NPHS. The target population of the CCHS includes individuals aged 12+ years living in private dwellings in any of the 10 provinces or 3 territories. We used data from all 2-year cycles of the CCHS from 2000 to 2018, in addition to single-year data from 2020. We omitted 2019 from the analysis since AT survey questions were included as optional content for this year and

selected only by a subset of provinces, thus precluding our ability to produce national estimates. Notably, the COVID-19 pandemic disrupted regularly scheduled data collection in 2020; thus, the data for this year are only representative of the months of January to March, and September to December, of provinces only.²⁵

Canadian Health Measures Survey

The CHMS is an ongoing cross-sectional health survey conducted every 2 years that began in 2007 and gathers health information through objective physical measures in addition to a personal interview with questionnaire. The target population of the CHMS includes household-dwelling individuals between the ages of 3 and 79 years (6–79 in cycle 1) residing in any of the 10 provinces. We used questionnaire data from all 6 available cycles of the CHMS.²⁶

Health Behaviour in School-aged Children Study

The HBSC study is an ongoing cross-sectional school-based survey of adolescents aged 11–15 years. The HBSC is a collaborative study, led by the World Health Organization, which was initiated in 1982 and currently has over 50 countries participating. Canada has administered the HBSC since 1989, targeting students in grades 6 to 10, with data collection repeated every 4 years.^{27,28}

Statistical Analysis

For each survey cycle, descriptive statistics including proportions and means, and 95% CIs summarized (1) the prevalence of AT and (2) the average hours spent on AT per week among those who reported engaging in any AT (note: this represents a subgroup of the Canadian population). Estimates were produced separately by mode of transportation (ie, walking and cycling) when possible and aggregated to produce an estimate of total AT. In instances where time spent in AT was measured using categorical response options, we used the midpoint of each range (eg, 1–5 h = 3 h) or the starting point of the highest category (eg, >20 h = 20 h) to produce a continuous measure. Age group- and sex-specific estimates were generated. Between-group differences in AT by age and sex were assessed using chi-square tests for AT prevalence and independent sample *t* tests or analysis of variance for time in AT. A Bonferroni correction was applied to adjust *P* values from pairwise comparisons by sex or age, and between-group statistical significance was assessed as *P* < .05. Cases missing AT data were excluded from their respective analyses.

To adjust for nonresponse bias and the complex sampling designs of the surveys, we applied the appropriate survey weights to the respective analyses. For the NPHS, CCHS, and CHMS, the bootstrap technique was used to estimate 95% CIs. All analyses were conducted in SAS Enterprise Guide (version 7.14; SAS, Inc).

Results

Overview of AT Measures on National Health Surveys

Table 1 in [Supplementary Material S1](#) (available online) provides an overview of the AT measures used on the national health surveys. AT behaviors were measured through varying questions both within and between surveys. AT survey questions differed regarding the destinations included (eg, AT to school, work, and for errands), their recall period (eg, past 3 mo and past 7 d), and the mode of transportation measured (ie, walking, cycling, and total

AT). The most recent AT questions on the CCHS and CHMS did not separately assess cycling and walking for AT and instead collected a measure of total AT. Response options, also, have varied over time with the use of either categorical or continuous measures.

Prevalence of AT

Figures 1 and 2 present prevalence of AT across surveys and time (see Supplementary Tables S1–S4 in [Supplementary Material S2](#) [available online]) and summarize the estimates. From 1994 to 2020 (Figure 1), the prevalence of any AT participation ranged from 25% (95% CI, 24.4–25.6; CCHS 2013–2014) to 85% (95% CI, 81.6–88.3; CHMS 2009–2011). When examining walking and cycling behaviors separately (Figure 2), a consistently larger proportion of the population reported walking to get to places, ranging from 22.9% (95% CI, 22.4–23.5; CCHS 2013–2014) to 84.6% (95% CI, 81.3–88.0; CHMS 2009). For cycling, estimates ranged from 4.6% (95% CI, 4.3–4.9; CCHS 2013–2014) to 9.3% (95% CI, 8.7–9.9; NPHS 1994–1995).

There was a steady increase in the proportion of those reporting any AT participation from 1996 (NPHS) to 2012 (CHMS); this is noteworthy because this period represents a long interval with comparable estimates across all 3 surveys which measured AT through the same survey questions and response options. This increase can be attributed to the concurrent rise in the prevalence of walking for AT, as rates of cycling remained relatively stable during this period on these surveys. From 2007 to 2014, the proportion of those reporting walking or cycling for AT in the CCHS was stable though significantly lower than the estimates

from years prior, a drop that coincides with the first modification to the CCHS AT survey questions to drop errands as a destination. Since 2014 and 2015, respectively, the CHMS and CCHS have employed the same AT questions rendering closer estimates for the prevalence of AT, ranging between 41.6% (95% CI, 33.8–49.3; CHMS 2016–2017) and 49.0% (95% CI, 48.5–49.5; CCHS 2015–2016).

Prevalence of AT by Sex

Figure 3 displays AT prevalence by sex. In general, and across survey years, a higher proportion of females than males reported engaging in any AT, ranging from 25.6% to 88.8% and 24.5% to 81.1%, respectively. This sex difference appears to narrow over time, evident in the CCHS and CHMS estimates (see Supplementary Tables S2 and S3 in [Supplementary Material S2](#) [available online]). Across all surveys and years where AT was measured by mode, the prevalence of walking for transport was significantly higher among females than males, ranging between 25.6% to 88.7% and 21.7% to 80.5%, respectively. Conversely, cycling prevalence was consistently and significantly higher among males than females, ranging from 5.8% to 12.2% and 3.1% to 6.9%, respectively. In youth, rates of walking were comparable between males and females while cycling rates were significantly higher among males than females (see Supplementary Table S4 in [Supplementary Material S2](#) [available online]).

Prevalence of AT by Age

Figure 4 displays AT prevalence stratified by age group. The highest proportion of AT participation was generally reported

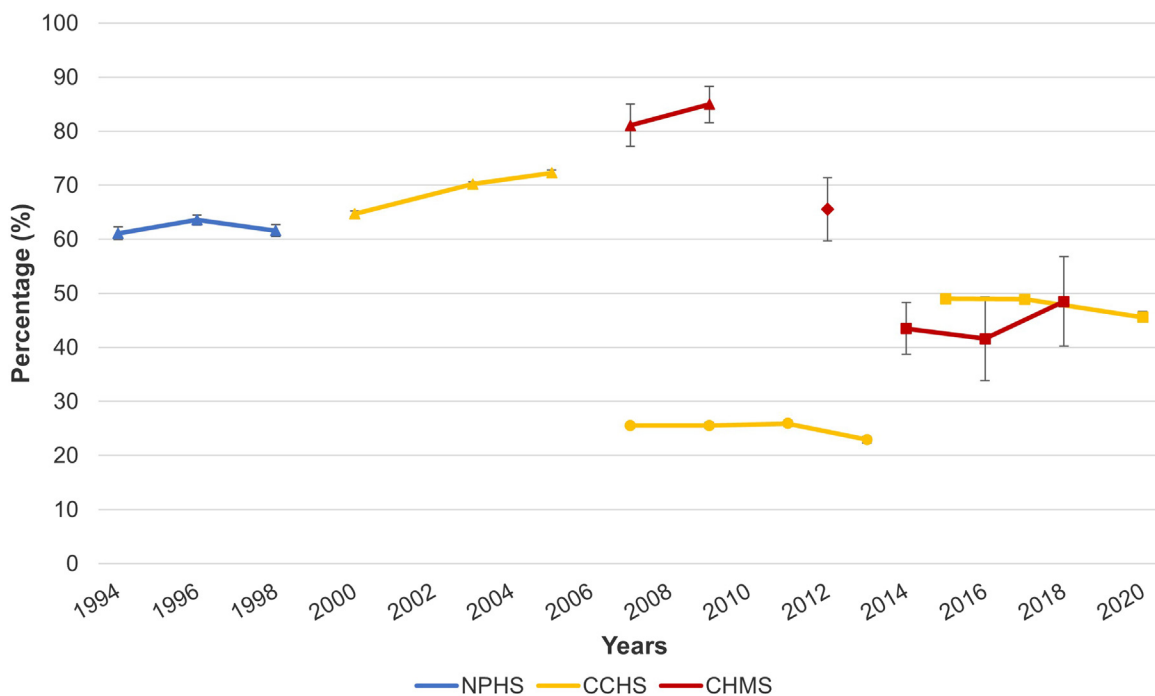


Figure 1 — Prevalence of self-reported active transportation participation among Canadians aged 12 years and older^a 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. ^aCHMS: ages 12–79 years. CCHS indicates Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

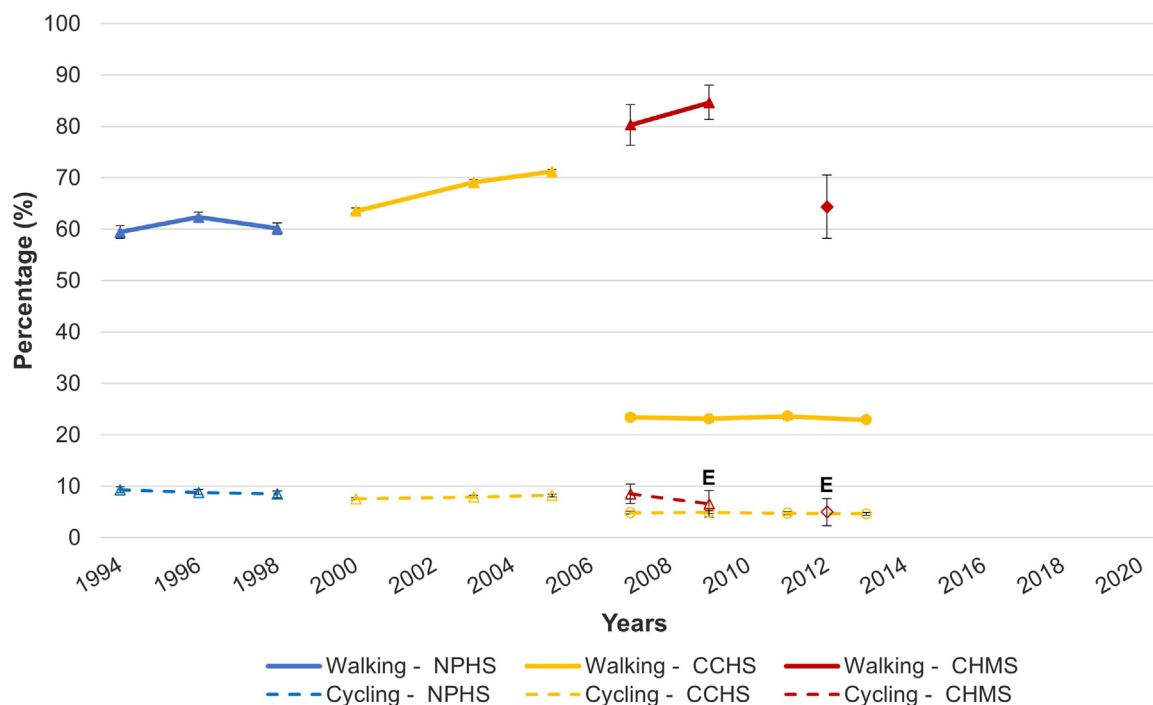


Figure 2 — Prevalence of self-reported walking and cycling for transportation among Canadians aged 12 years and older^a 1994–2014. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014; CHMS: 2007–2009, 2009–2011, 2012–2013. Legend: Data points have been joined with lines within each survey for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. E: Interpret with caution due to high sampling variability. ^aCHMS: ages 12–79 years. CCHS indicates Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

by youth and decreased with age, ranging from 53.7% to 90.3% in youth 12 to 17 years, followed by 30.7% to 90.5% in adults 18–34 years, 17.2% to 81.7% in adults 35–49 years, 14.2% to 81.6% in adults 50–64 years, 8.9% to 83.8% in adults 65–79 years, and 5.5% to 58.8% in adults 80+ years. Similar results were observed when examining rates by mode of AT, with the highest prevalence of walking or cycling reported by youth and young adults, and the lowest rates typically reported among older adults (see Supplementary Tables S1–S4 in [Supplementary Material S2](#) [available online]).

Amount of AT

Figures 5 and 6 present the average amount of time in AT among those who engage in AT (see Supplementary Tables S5–S7 in [Supplementary Material S2](#) [available online]) summarize the estimates. From 1994 to 2020 (Figure 5), the average self-reported weekly hours spent in AT ranged from 1.4 hours per week (CCHS 2007–2012) to 6.7 hours per week (95% CI, 6.6–6.8; CCHS 2000–2001 and CCHS 2005). When surveyed on walking and cycling behaviors separately (Figure 6), Canadians consistently reported spending more time walking. Walking for AT ranged from 1.4 hours per week (CCHS 2007–2014) to 6.4 hours per week (95% CI, 6.4–6.5; CCHS 2000–2001). For cycling, estimates ranged from 0.8 hours per week (CCHS 2007–2012) to 3.7 hours per week (CCHS 2003 and 2005).

From 1996 to 2009, when questions were the same across each of the NPHS, CCHS, and CHMS, there was a slight rise and subsequent fall in the average weekly hours spent on any mode of AT with a peak of 6.5 hours per week (95% CI, 6.4–6.6) in 2000

(CCHS). In 2007, when AT survey questions were first modified in the CCHS, there was a significant drop in the amount of time people reported spending on AT though these estimates remained stable until 2014, consistent at 1.4 to 1.5 hours per week for walking and 0.8 to 0.9 hours per week for cycling. During the period where AT survey questions have been the same in both the CHMS and CCHS (since 2014 and 2015), estimates have risen and remained relatively similar, ranging between 3.0 hours per week (95% CI, 2.5–3.4; CHMS 2016–2017) and 4.0 hours per week (95% CI, 3.5–3.7; CCHS 2015–2016 and 2020) in both surveys.

Amount of AT by Sex

Figure 7 displays amounts of AT by sex. Across all surveys and years, males typically reported spending a greater amount of time in AT than females, with males spending between 1.4 and 7.0 hours per week on any AT while females reported spending between 1.4 and 6.5 hours per week on any AT. This trend was consistent regardless of mode of transport, with males reporting a greater amount of time walking and cycling, on average, than females.

Amount of AT by Age

Figure 8 displays amounts of AT by age. Young adults (18–34 y) have generally reported spending the greatest amount of time spent in AT with estimates ranging between 1.5 and 7.1 hours per week, compared with 1.1 to 6.7 hours per week in youth aged 12–17 years, 1.4 to 7 hours per week in adults aged 35–49 years, 1.4 to 6.6 hours per week in adults aged 50–64 years, 1.2 to 5.9 hours per week in adults aged 65–79 years, and 1.5 to 5.1 hours per week in adults aged 80+ years. A similar result is observed when examining

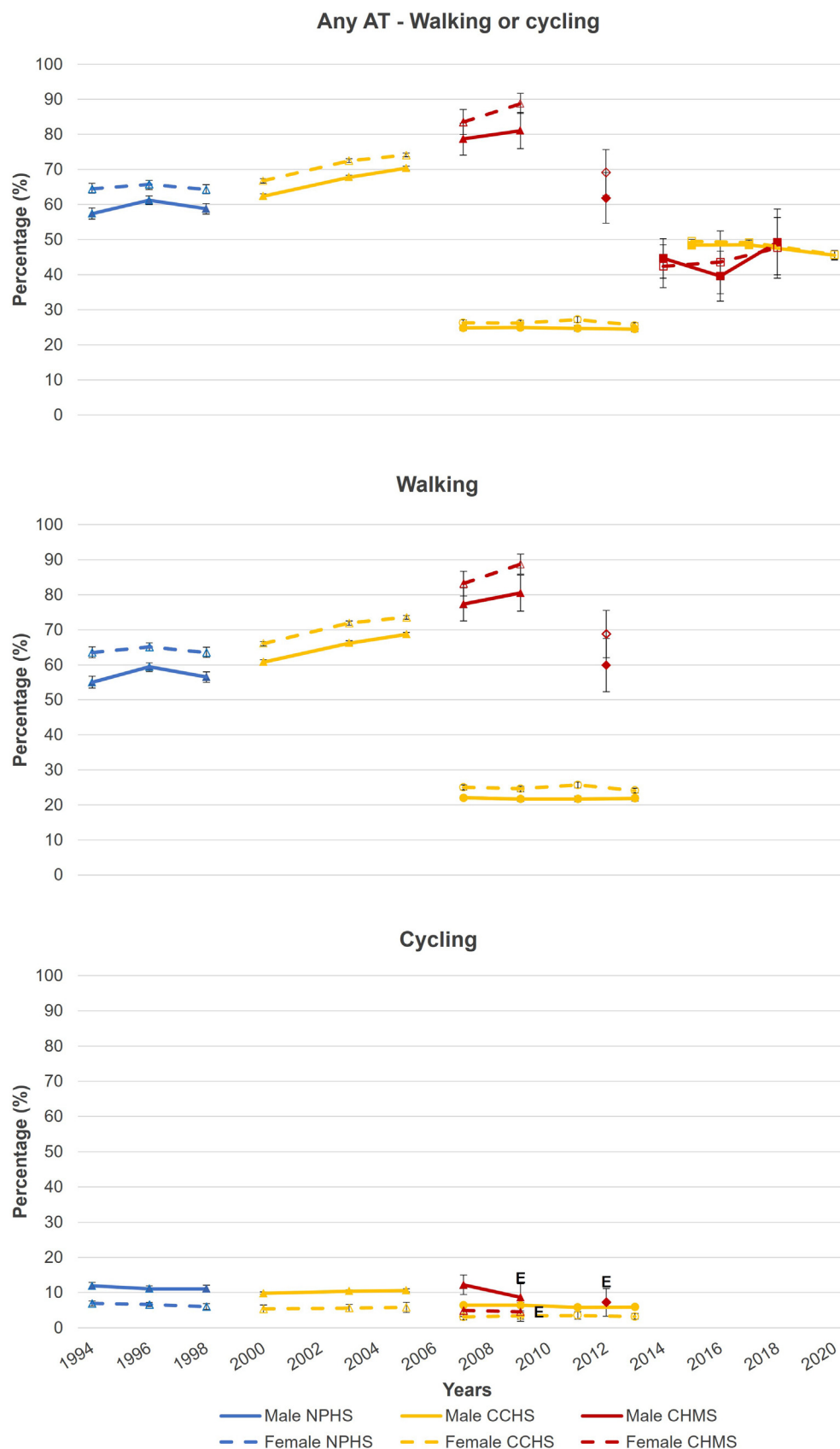


Figure 3 — Prevalence of self-reported participation in active transportation among Canadians aged 12 years and older^a by sex and mode, 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. ^aCHMS: ages 12–79 years. CCHS indicates Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

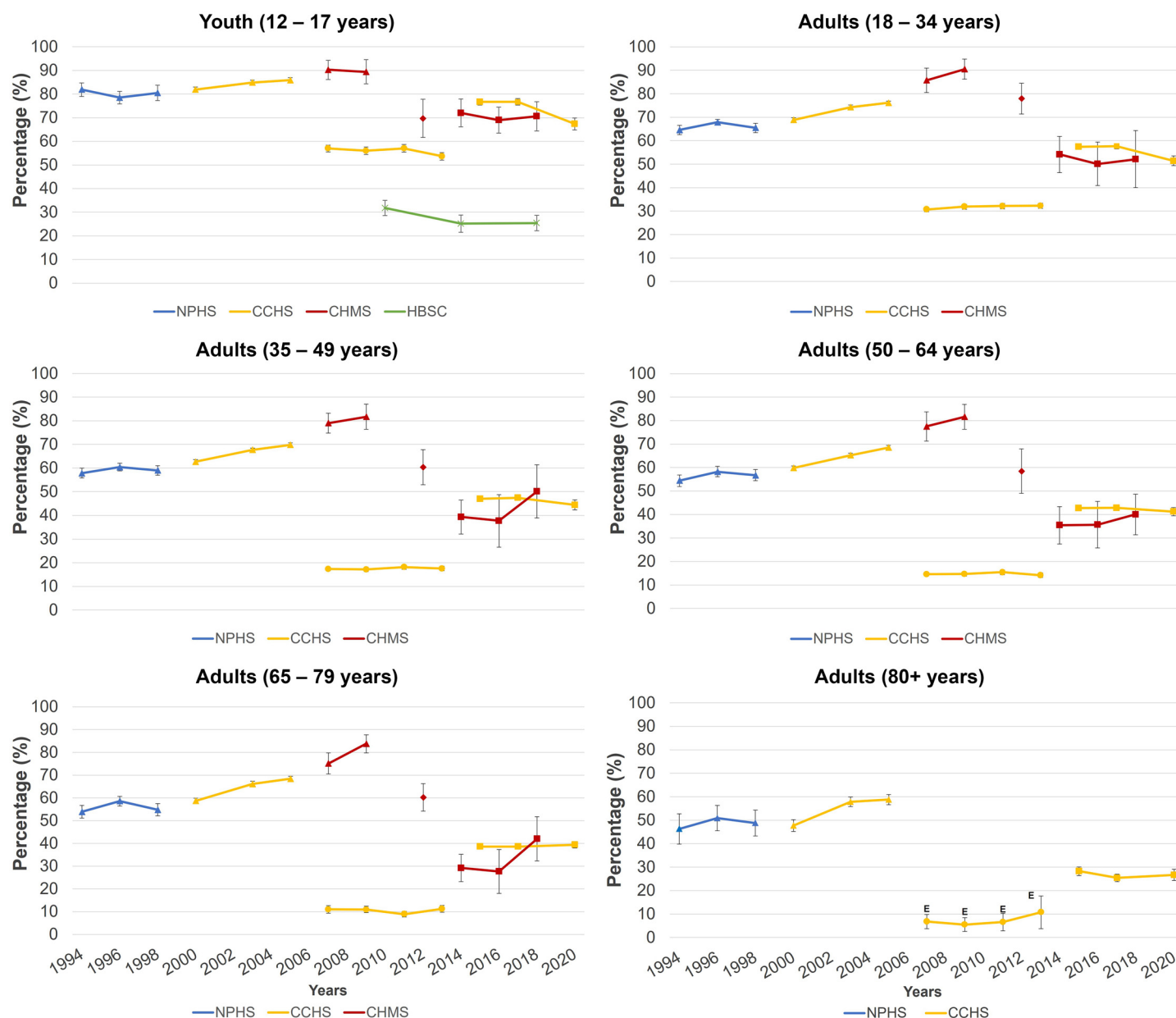


Figure 4 — Prevalence of self-reported participation in active transportation among Canadians aged 12 years and older^a by age group, 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019; HBSC: 2010, 2014, 2018. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. ^aCHMS: ages 12–79 years. CCHS indicates Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; HBSC, Health Behaviour in School-aged Children; NPHS, National Population Health Survey.

estimates by mode of transport (see Supplementary Tables S6 and S7 in [Supplementary Material S2](#) [available online]), such that younger adults generally report the greatest amount of time walking or cycling compared with other age groups.

Discussion

This study provides the first comprehensive analysis of historical AT surveillance data in Canada. The results reveal significant variability in AT behaviors over the years as measured through Canada's population health surveys.

Plotting estimates of AT over time, even in the absence of formal trend tests, provides a means of exploring whether certain patterns remain regardless of changes in measurement. For example, when compared with their male counterparts, a higher proportion of females report walking, with the opposite being true for cycling—a finding that is consistent with reported trends in the literature.^{29–31} Regardless of mode, however, males report spending more total time in AT which is consistent with what has been previously reported in Canada.³² Additionally, youth have reported the highest rates of AT participation, with prevalence generally decreasing with increasing age. Time spent in AT also tends to

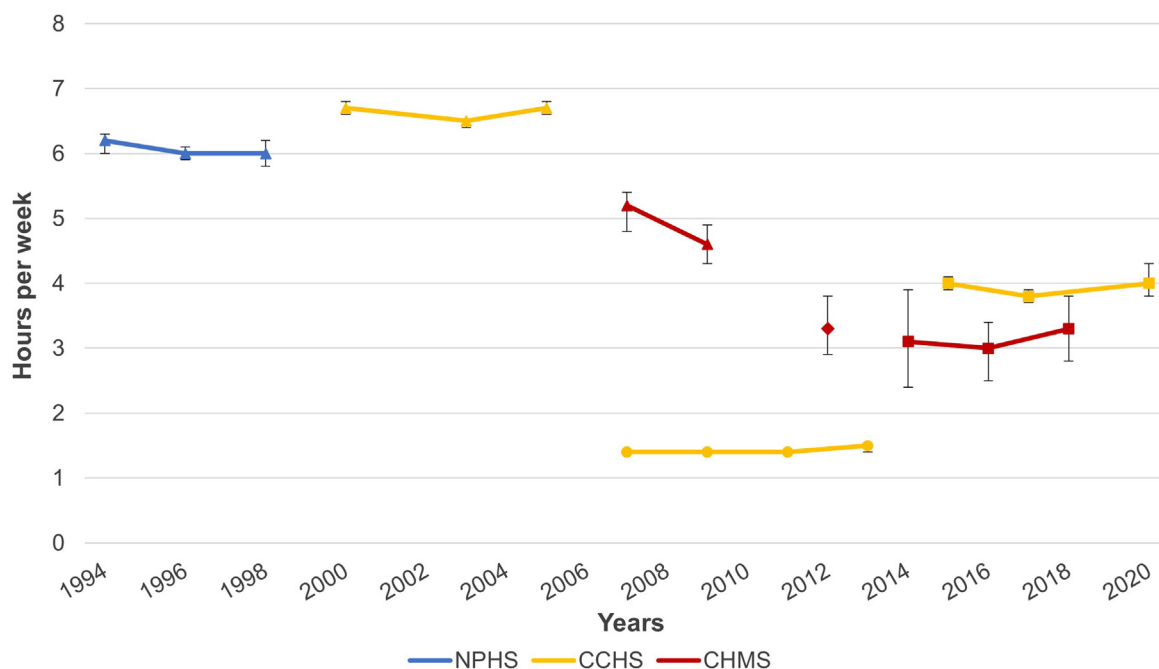


Figure 5 — Average self-reported weekly hours spent on AT among Canadians aged 12 years and older^a who reported engaging in any AT, 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. ^aCHMS: ages 12–79 years. AT indicates active transportation; CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

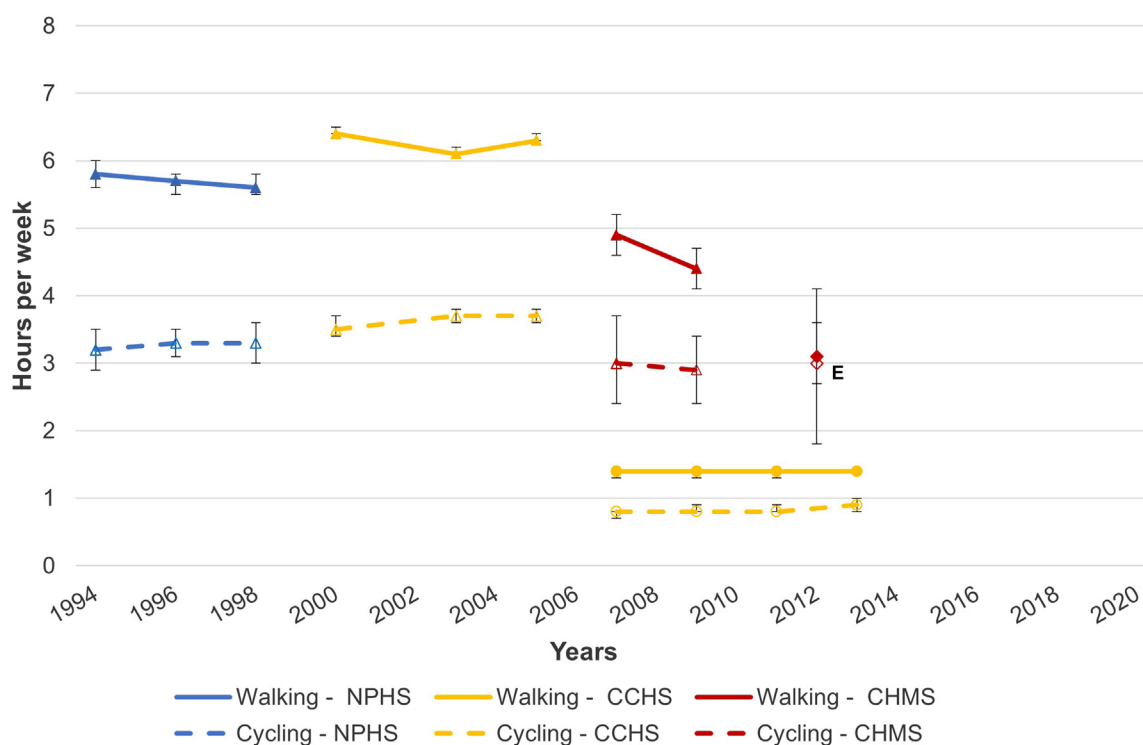


Figure 6 — Average self-reported weekly hours spent walking and cycling for transportation among Canadians aged 12 years and older^a who reported engaging in any AT, 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. E: Interpret with caution due to high sampling variability. ^aCHMS: ages 12–79 years. AT indicates Active transportation; CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

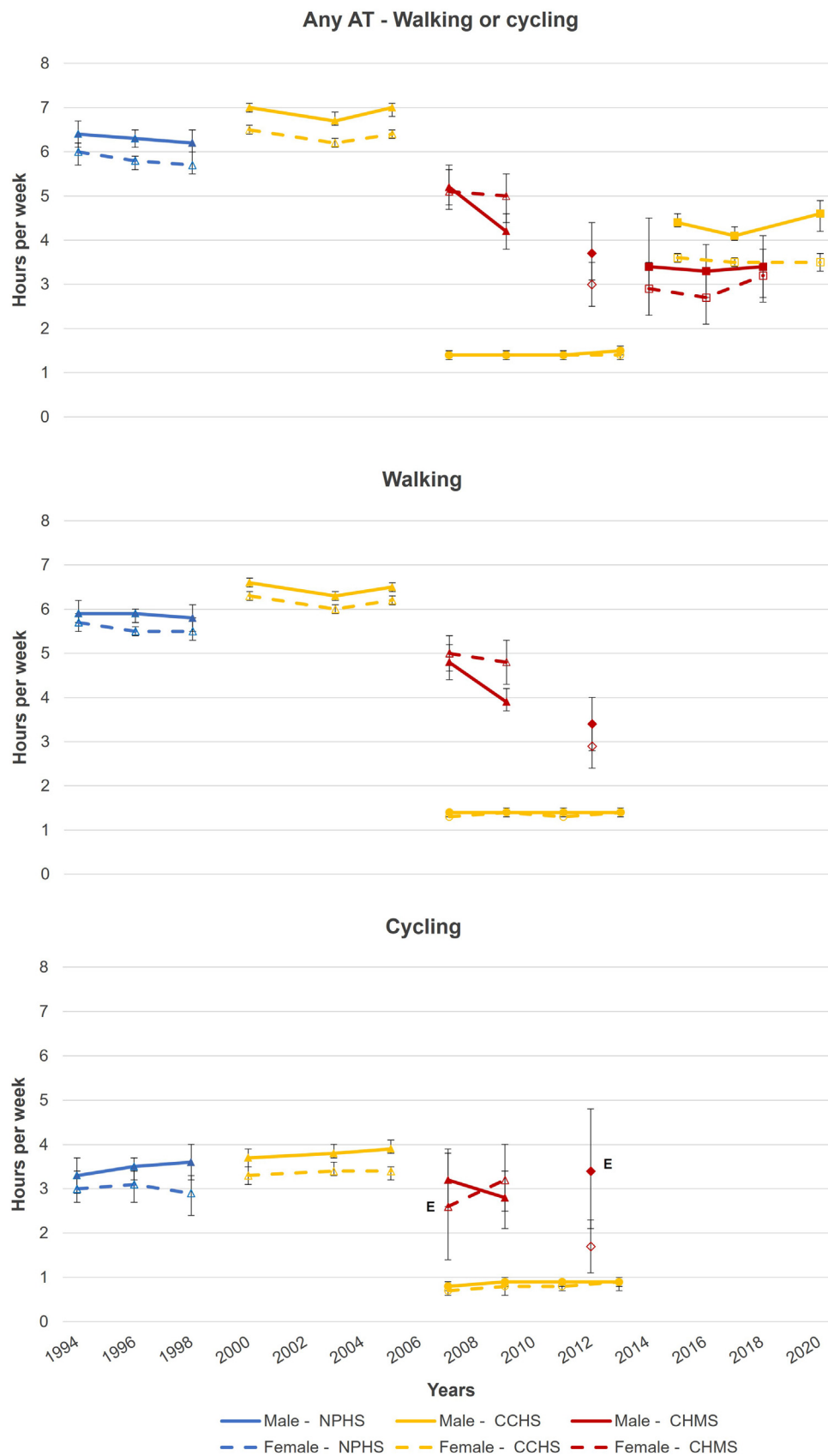


Figure 7 — Average self-reported weekly hours spent on AT among Canadians aged 12 years and older^a who reported engaging in any AT by sex and mode, 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. E: Interpret with caution due to high sampling variability. ^aCHMS: ages 12–79 years. AT indicates active transportation; CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

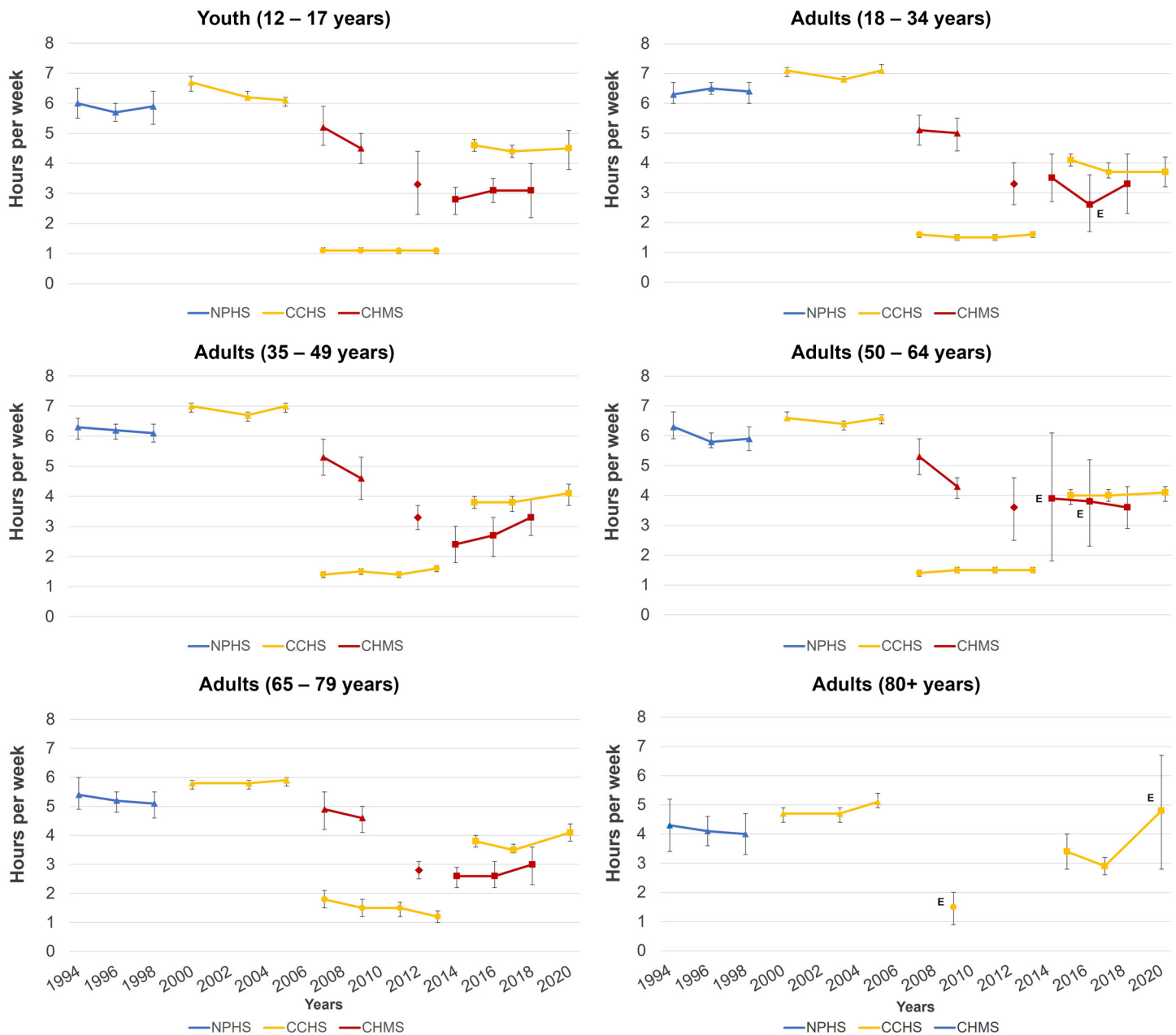


Figure 8 — Average self-reported weekly hours spent on AT among Canadians aged 12 years and older^a who reported engaging in any AT by age group, 1994–2020. Data sources: NPHS: 1994–1995, 1996–1997, 1998–1999; CCHS: 2000–2001, 2003, 2005, 2007–2008, 2009–2010, 2011–2012, 2013–2014, 2015–2016, 2017–2018, 2020; CHMS: 2007–2009, 2009–2011, 2012–2013, 2014–2015, 2016–2017, 2018–2019. Legend: Data points have been joined with lines within each survey only for years where survey questions and response options were the same. Data points marked with the same shape represent cycles where questions and response options were consistent across surveys. E: Interpret with caution due to high sampling variability. ^aCHMS: ages 12–79 years. AT indicates active transportation; CCHS, Canadian Community Health Survey; CHMS, Canadian Health Measures Survey; NPHS, National Population Health Survey.

decrease with age, with young adults generally spending the most time in AT. These trends of higher AT among males and younger ages correspond to trends observed in the United States²⁰ and for physical activity in general.^{33,34} Though rates of participation (walking in particular) appear to have risen earlier in the time series (1998–2009), changes to the survey questions thereafter preclude our ability to identify whether these trends continued or changed.

The lack of consistency in measurement of AT within public health surveillance systems over iterations of the surveys renders

assessment of temporal trends impossible. Others who have conducted similar work examining AT trends using US surveillance data have previously noted this challenge, emphasizing how differing questions can be measuring different underlying constructs or components of AT altogether which may explain the large variations in estimates.²⁰ For example, in the first modification to AT survey questions in the CCHS in 2007, AT for the purpose of “errands” was omitted from the questions for the first time, measuring only AT for “school or work.” Restricting the purpose of AT in this way appears to have resulted in a sharp

decline in estimates of prevalence, down to their lowest levels in the time series. However, once a more comprehensive list of destinations and purposes were included in the most recent iteration of survey questions (eg, walking or cycling to a bus stop), estimates rose to values more consistent with those prior to the modification in 2007. This finding supports that destinations beyond work or school³⁵ and multimodal travel bouts are a potentially important source of AT among Canadians and integrating them into surveillance can improve the sensitivity of survey questions measuring AT.

Changes to recall periods, or the period of time over which respondents are asked to recall their behaviors, may have also contributed to the variability observed in AT estimates—a finding that has also been identified in other studies.^{36–40} Longer recall lengths can be more susceptible to bias due to the increasing probability of recall decay and use of recall strategies.⁴¹ Estimates of both prevalence and amount of AT were at their highest levels early in the time series when in all 3 surveys, respondents were asked about their behavior in a “typical week in the past 3 months.” More recently, however, respondents have been asked to report on AT in the last 7 days, providing an anchor period for recall. It is, therefore, unclear whether AT was previously higher or whether the recall period resulted in a greater likelihood of a positive response for engaging in some amount of AT.

The disaggregation of AT by mode of transportation reveals clear and important differences. For example, a higher proportion of Canadians report walking for transportation than cycling, and those who engage in AT spend more time per week walking, on average, than cycling. These differences become obscured when the behaviors are not measured independently in surveillance systems, as is found in the most recent cycles of the CCHS and CHMS. Given that the health benefits, barriers, and facilitators of walking and cycling can be different,^{42–44} it is important that these modes of AT be measured separately. Additionally, walking and cycling offer distinct and separate advantages for commuting actively (eg, popularity, distance and speed covered, equipment, and physical efficacy requirements).⁴⁵ Separating the measurement of these 2 distinct and most popular forms of AT provides an important means of assessing their respective responsiveness to interventions and policies. Future surveillance may also look to parse out e-bike use given its emerging popularity and acknowledgment as a form of physical activity.^{46–48} It may also improve survey respondents’ recall due to greater activity specificity.

In many countries, time-use surveys and travel surveys are used to gather detailed information on the travel behaviors of their citizens, including their engagement in AT, distances traveled, destinations, and reasons for travel.^{49,50} These surveys are often restricted to a recent recall period (eg, past 24 h) with a detailed recall across the day including trip origins, destinations, mode of transport, trip purpose, and duration of trip, all providing important insight into AT behaviors. While these surveys provide more detailed information, they do not collect or provide health data to examine associations. Traditional health surveys may be augmented by including questions related to factors associated with AT such as the perceived built environment, barriers or facilitators to participation, or social norms. Ideally, an AT surveillance system for Canada would include household travel surveys in addition to the existing health surveys, time use surveys, and census.

Strengths and Limitations

The chief strength of this study is its use of data from large, nationally representative health surveys. However, we examined

only self-reported data, often from 1 or 2 questions, which is subject to multiple sources of bias including social desirability bias and recall bias. Novel methods of deriving data on AT from devices (eg, accelerometers + GPS) can help overcome some of the self-report limitations. However, while devices can provide information on intensity, volume, and location, they cannot identify type or purpose. We still believe there is a lot of value in collecting type- and domain-specific information by self-report especially for population surveillance. Volume of AT is presented using mean hours per week. While we recognize these data are not always normally distributed, means are presented rather than medians due to ease of interpretation by policy makers, as well as comparability with international estimates. Importantly, formal statistical testing for trends was largely inappropriate due to the changes in survey methodology. Providing these data across time helps to show the within-measure stability/reliability but also provides context to understanding how question changes affected point estimates. For example, as previously mentioned, when the questionnaire dropped “errands” from the destination options of “school, work, or errands,” the prevalence dropped substantially.

It is important to note that since our paper examined the time spent in AT among those who reported engaging in AT, the estimates are higher than those traditionally reported within surveillance for time spent in AT among the entire Canadian population.⁵¹ The estimates presented herein reflect AT as an important source of PA among those that engage in the behavior. Given that estimates of the amount of time in AT can vary by denominator, this is an important area of consideration for measurement and comparisons. While a core objective of this study was to examine and describe patterns in AT, none of the surveys used have measured AT in children (<12 y old); thus, we were not able to describe any trends in this age group. The Canadian Health Survey on Children and Youth, active since 2019, does include measures of AT and has the potential to fill this gap in Canadian AT surveillance moving forward but currently only asks about the journey to school.⁵² Additionally, while gender (sociocultural) has demonstrated to be an important correlate of physical activity behaviors and experiences, the surveys included in this study have only measured sex (biologic).^{53,54} Fortunately, the most recent cycles of the CHMS and CCHS, for which data are not yet available, include measures of self-identified gender which will afford the ability to better explore the role of gender as a sociocultural correlate of the various domains of physical activity, including AT, in the future.

Conclusions

This is the first comprehensive look at the measurement and prevalence of AT across time on Canadian national health surveys. Changes in survey questions across years have precluded our ability to assess trends in AT as it is not possible to determine whether a change is the result of differences in measures or population behaviors. There was some evidence that AT increased between 1994 and 2011, and while current prevalence is lower, it is not clear whether this is reflective of true behavior change. Some consistent findings were observed, with youth and younger adults and males more likely to engage in AT and report higher volumes of AT compared with older adults and females. Additionally, females were more likely to report walking for AT than males, whereas males were more likely to report cycling for AT than females. While the results of the current analysis cannot be generalized beyond the Canadian population, this study’s close examination of AT

participation as measured through Canadian population health surveys may be valuable in its ability to inform the practices of other national and global systems of PA surveillance. Considering recent commitments at various levels to develop more AT-supportive environments and increase overall physical activity levels, it is especially imperative to have public health surveillance systems for monitoring and evaluating AT behaviors and temporal trends. Careful consideration should be given to survey and question design to ensure that variability in survey questions is minimized (ie, recall period and destinations) for comparability purposes, that trends can be disaggregated by mode of transportation, and allow for the analysis of behaviors across a variety of sociodemographic identifiers to capture important disparities.

Acknowledgments

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada. **Availability of Data and Materials:** The data sets analyzed for this study are available through the Research Data Centers (RDC) Program at Statistics Canada (<https://www.statcan.gc.ca/en/microdata/data-centres>). **Authors Contributions:** Designed the study, conducted the analyses, drafted the initial manuscript, and revised the manuscript: Borhani. Conducted the environmental scan and reviewed and revised the manuscript: Walker. Conceptualized and designed the study and reviewed and revised the manuscript: Butler. SAP Designed the study and reviewed and revised the manuscript: Prince. Conducted analyses and reviewed and revised the manuscript: Contreras and Lavergne. Approved the final manuscript: All authors. **Ethics Approval and Consent to Participate:** Approval for the conduct of the NPHS, CCHS, and CHMS was obtained from Health Canada's Research Ethics Board. Approval for the conduct of the HBSC was obtained from both Health Canada/Public Health Agency of Canada and Queens University's Research Ethics Boards. Informed consent was obtained from all participants.

References

1. Prince SA, Lancione S, Lang JJ, Amankwah N, Groh M, Garcia AJ. Are people who use active modes of transportation more physically active? An overview of reviews across the life course. *Transp Rev*. 2021;42(1):262. doi:10.1080/01441647.2021.2004262
2. Figueiredo N, Rodrigues F, Morouço P, Monteiro D. Active commuting: an opportunity to fight both climate change and physical inactivity. *Sustainability*. 2021;13(8):4290. doi:10.3390/su13084290
3. Gravett N, Mundaca L. Assessing the economic benefits of active transport policy pathways: opportunities from a local perspective. *Transp Res Interdiscip Perspect*. 2021;11:100456. doi:10.1016/j.trip.2021.100456
4. Sallis JF, Spoon C, Cavill N, Engelberg JK, Gebel K, Parker M. Co-benefits of designing communities for active living: an exploration of literature. *Int J Behav Nutr Phys Act*. 2015;12(1):30. doi:10.1186/s12966-015-0188-2
5. Patterson R, Panter J, Vamos EP, Cummins S, Millett C, Lavery AA. Associations between commute mode and cardiovascular disease, cancer, and all-cause mortality, and cancer incidence, using linked Census data over 25 years in England and Wales: a cohort study. *Lancet Planet Health*. 2020;4(5):e186–e194. doi:10.1016/S2542-5196(20)30079-6
6. Dinu M, Pagliai G, Macchi C, Sofi F. Active commuting and multiple health outcomes: a systematic review and meta-analysis. *Sports Med*. 2019;49(3):437–452. doi:10.1007/s40279-018-1023-0
7. Celis-Morales CA, Lyall DM, Welsh P, Anderson J, Steell L, Guo Y. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. *BMJ*. 2017;357:j1456. doi:10.1136/bmj.j1456
8. Martin A, Goryakin Y, Suhrcke M. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. *Prev Med*. 2014;69:296–303. doi:10.1016/j.ypmed.2014.08.023
9. Barajas JM, Braun LM. Are cycling and walking good for all? Tracking differences in associations among active travel, socio-economics, gentrification, and self-reported health. *J Transp Health*. 2021;23:101246. doi:10.1016/j.jth.2021.101246
10. Larouche R, Faulkner G, Tremblay MS. Active travel and adults' health: the 2007-to-2011 Canadian health measures surveys. *Health Rep*. 2016;27(4):10–18. PubMed ID: 27096619
11. World Health Organization. *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World* [Internet]. 2018:101. <https://apps.who.int/iris/handle/10665/272722>. [Accessed June 4, 2023].
12. Butler GP, Roberts KC, Kropac E, Rao DP, Branchard B, Prince SA. At-a-glance Conceptualizing a framework for the surveillance of physical activity, sedentary behaviour and sleep in Canada. *Health Promot Chronic Prev Can*. 2019;39(5):201–204. doi:10.24095/hpcdp.39.5.04
13. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annu Rev Public Health*. 2006;27(1):297–322. doi:10.1146/annurev.publhealth.27.021405.102100
14. World Health Organization (WHO). Promoting walking and cycling [Internet]. 2022. <https://www.who.int/activities/promoting-walking-and-cycling>
15. Public Health Agency of Canada. The Chief Public Health Officer's Report on the State of Public Health in Canada 2017—designing healthy living [Internet]. 2017. <https://www.canada.ca/en/public-health/services/publications/chief-public-health-officer-reports-state-public-health-canada/2017-designing-healthy-living.html>
16. Infrastructure Canada. Canada's National Active Transportation Strategy [Internet]. 2021. <https://www.infrastructure.gc.ca/trans/active-strat-actif-eng.html>
17. Gong W, Yuan F, Feng G, Ma Y, Zhang Y, Ding C. Trends in transportation modes and time among Chinese population from 2002 to 2012. *Int J Env Res Public Health*. 2020;17(3):945. doi:10.3390/ijerph17030945
18. Grize L, Bringolf-Isler B, Martin E, Braun-Fahrlander C. Trend in active transportation to school among Swiss school children and its associated factors: three cross-sectional surveys 1994, 2000 and 2005. *Int J Behav Nutr Phys Act*. 2010;7(1):28. doi:10.1186/1479-5868-7-28
19. Ussery EN, Carlson SA, Whitfield GP, Watson KB, Berrigan D, Fulton JE. Transportation and leisure walking among U.S. adults: trends in reported prevalence and volume, National Health Interview Survey 2005–2015. *Am J Prev*. 2018;55(4):533–540. doi:10.1016/j.amepre.2018.05.027
20. Whitfield GP, Paul P, Wendel AM. Active transportation surveillance – United States, 1999–2012. *Morb Mortal Wkly Rep*. 2015;64(7):1–17.
21. Pucher J, Buehler R. Why Canadians cycle more than Americans: a comparative analysis of bicycling trends and policies. *Transp Policy*. 2006;13(3):265–279. doi:10.1016/j.tranpol.2005.11.001
22. Pucher J, Buehler R. Sustainable transport in Canadian cities: cycling trends and policies. *Berkeley Plan J* [Internet]. 2006. <https://escholarship.org/uc/item/0rr0t06s>

23. Pucher J, Buehler R, Seinen M. Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transp Res Part Policy Pr.* 2011;45(6):451–475. doi:10.1016/j.tra.2011.03.001
24. Statistics Canada. National population health survey: household component, cross-sectional (NPHS) [Internet]. 2007. <https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=3732>
25. Statistics Canada. Canadian Community Health Survey—annual component (CCHS) [Internet]. 2021. <https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226#a1>
26. Statistics Canada. Canadian Health Measures Survey (CHMS) [Internet]. 2018. <https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5071>
27. Public Health Agency of Canada. The Health Behaviour in School-aged Children (HBSC) Study in Canada [Internet]. 2010. <https://www.canada.ca/en/public-health/services/health-promotion/childhood-adolescence/programs-initiatives/school-health/health-behaviour-school-aged-children.html>
28. About | HBSC study [Internet]. 2022. <https://hbsc.org/about/>
29. Goel R, Oyeboode O, Foley L, Tatah L, Millett C, Woodcock J. Gender differences in active travel in major cities across the world. *Transportation.* 2022;50(2):733–749. doi:10.1007/s11116-021-10259-4
30. Heesch KC, Sahlqvist S, Garrard J. Gender differences in recreational and transport cycling: a cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints. *Int J Behav Nutr Phys Act.* 2012;9(1):106. doi:10.1186/1479-5868-9-106
31. Pollard TM, Wagnild JM. Gender differences in walking (for leisure, transport and in total) across adult life: a systematic review. *BMC Public Health.* 2017;17(1):341. doi:10.1186/s12889-017-4253-4
32. Juneau CE, Potvin L. Trends in leisure-, transport-, and work-related physical activity in Canada 1994–2005. *Prev Med.* 2010;51(5):384–386. doi:10.1016/j.ypmed.2010.09.002
33. Gropper H, John JM, Sudeck G, Thiel A. The impact of life events and transitions on physical activity: a scoping review. *PLoS One.* 2020;15(6):e0234794. doi:10.1371/journal.pone.0234794
34. Aleksovska K, Puggina A, Giralaldi L, Buck C, Burns C, Cardon G. Biological determinants of physical activity across the life course: a “Determinants of Diet and Physical Activity” (DEDIPAC) umbrella systematic literature review. *Sports Med—Open.* 2019;5(1):9. doi:10.1186/s40798-018-0173-9
35. Millward H, Spinney J, Scott D. Active-transport walking behavior: destinations, durations, distances. *J Transp Geogr.* 2013;28:101–110. doi:10.1016/j.jtrangeo.2012.11.012
36. Sirard JR, Hannan PJ, Cutler GJ, Graham DJ, Neumark-Sztainer D. Evaluation of two self-report measures of physical activity with accelerometry in young adults. *J Phys Act Health.* 2013;10(1):85–96. doi:10.1123/jpah.10.1.85
37. Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med.* 2003;37(3):197–206. doi:10.1136/bjsm.37.3.197
38. Novak B, Holler P, Jaunig J, Ruf W, Poppel MNM, Sattler MC. Do we have to reduce the recall period? Validity of a daily physical activity questionnaire (PAQ24) in young active adults. *BMC Public Health.* 2020;20(1):72. doi:10.1186/s12889-020-8165-3
39. Prince SA, Melvin A, Roberts KC, Butler GP, Thompson W. Sedentary behaviour surveillance in Canada: trends, challenges and lessons learned. *Int J Behav Nutr Phys Act.* 2020;17(1):34. doi:10.1186/s12966-020-00925-8
40. Chinapaw MJM, Mokkink LB, Poppel MNM, Mechelen W, Terwee CB. Physical activity questionnaires for youth. *Sports Med.* 2010;40(7):539–563. doi:10.2165/11530770-000000000-00000
41. Conrad FG, Brown NR, Cashman ER. Strategies for estimating behavioural frequency in survey interviews. *Memory.* 1998;6(4):339–366. doi:10.1080/741942603
42. Clark A, Scott D. Barriers to walking: an investigation of adults in Hamilton (Ontario, Canada). *Int J Env Res Public Health.* 2016;13(2):179. doi:10.3390/ijerph13020179
43. Pucher J, Dijkstra L. Promoting safe walking and cycling to improve public health: lessons from The Netherlands and Germany. *Am J Public Health.* 2003;93(9):1509–1516. doi:10.2105/AJPH.93.9.1509
44. Ton D, Duives DC, Cats O, Hoogendoorn-Lanser S, Hoogendoorn SP. Cycling or walking? Determinants of mode choice in the Netherlands. *Transp Res Part Policy Pr.* 2019;123:7–23. doi:10.1016/j.tra.2018.08.023
45. Perks TA. Investigating the physical activity behaviors of Canadian adults over time: multilevel sex and age group trajectories across 2 decades. *J Phys Act Health.* 2017;14(12):933–942. doi:10.1123/jpah.2017-0130
46. Bourne JE, Cooper AR, Kelly P, Kinnear FJ, England C, Leary S, et al. The impact of e-cycling on travel behaviour: a scoping review. *J Transp Health.* 2020;19:100910. doi:10.1016/j.jth.2020.100910
47. Bourne JE, Sauchelli S, Perry R, Page A, Leary S, England C, et al. Health benefits of electrically-assisted cycling: a systematic review. *Int J Behav Nutr Phys Act.* 2018;15(1):116. doi:10.1186/s12966-018-0751-8
48. Jenkins M, O'Rourke N, Lustosa LG, La Delfa N, Dogra S. Self-selected pedal-assist E-bike use in older adults is moderate-vigorous intensity. *J Transp Health.* 2023;31:101647. doi:10.1016/j.jth.2023.101647
49. Harms T, Gershuny J, Olaru D. Using time-use data to analyse travel behaviour: findings from the UK. *Transp Res Procedia.* 2018;32:634–648. doi:10.1016/j.trpro.2018.10.007
50. National Household Travel Survey (NHTS). Policy | Federal highway administration [Internet]. 2022. <https://www.fhwa.dot.gov/policy/information/nhts.cfm>
51. Center for Surveillance and Applied Research, Public Health Agency of Canada. Physical Activity, Sedentary Behaviour and Sleep (PASS) Indicators Data Tool, 2023 Edition. *Public Health Infobase* [Internet]. 2023. <https://health-infobase.canada.ca/pass/data-tool?index=47>
52. Statistics Canada. Canadian Health Survey on Children and Youth (CHSCY) [Internet]. 2019. <https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5233>
53. Calzo JP, Roberts AL, Corliss HL, Blood EA, Kroshus E, Austin SB. Physical activity disparities in heterosexual and sexual minority youth ages 12–22 years old: roles of childhood gender nonconformity and athletic self-esteem. *Ann Behav Med Publ Soc Behav Med.* 2014;47(1):17–27. doi:10.1007/s12160-013-9570-y
54. Spencer RA, Rehman L, Kirk SF. Understanding gender norms, nutrition, and physical activity in adolescent girls: a scoping review. *Int J Behav Nutr Phys Act.* 2015;12(1):8. doi:10.1186/s12966-015-0166-8