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Occupational and sex differences in active commuting among Canadian workers from 2006 to 2016

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ABSTRACT

Background
Active commuting (AC) to and from work is associated with numerous health benefits, through increased physical activity. This study examined whether occupation types and part-time work, by sex, were associated with AC in a population-based sample of Canadian workers.

Data and methods
Cross-sectional public use microdata files from the 2006 (n=363,048), 2011 (n=370,672), and 2016 (n=362,310) Census of Population were examined. Multinomial logistic regression models were used to estimate the odds of cycling, walking, and using public transit, relative to using a private motorized vehicle, by occupation and sex. Time trends in mode share were also analyzed.

Results
In 2016, commuting by private motorized vehicle and cycling were more common among males, while public transit and walking were more common among females. Occupations in art, culture, recreation, and sport were associated with the greatest odds of cycling (odds ratio [OR]=3.02, 99% confidence interval [CI]: 2.65 to 3.39), while those in trades, transportation, natural resources, and manufacturing had the lowest odds of cycling (OR=0.47, 99% CI: 0.44 to 0.51) and walking (OR=0.36, 99% CI: 0.33 to 0.38). Since 2006, relative declines of 1% and 8% in the proportion of workers commuting by driving and walking, respectively, were observed (absolute change of -1% each). Relative increases of 14% and 12% were observed for cycling and public transit, respectively (absolute changes of less than 1% and 1.5%, respectively).

Interpretation
This study found that sex and occupation are important correlates of AC among Canadian workers. Further research aimed at understanding occupational barriers and facilitators may inform future AC interventions.

Keywords
Physical activity, active transportation, occupational health, workplace, epidemiology

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What is already known on this subject?

- Most Canadian workers do not meet the physical activity recommendation of 150 minutes of moderate-to-vigorous intensity physical activity per week.

- Active commuting via cycling and walking to and from work is associated with health, economic, and environmental benefits.

- Occupational characteristics may facilitate or impede active commuting. Studies that have examined occupational differences in active commuting have used small non-representative samples and have not generally separated results by the type of active commuting, and most have not focused on describing gender and sex differences.

What does this study add?

- Workers in trades, transportation, natural resources, and manufacturing occupations were least likely to commute actively, compared with using a private motorized vehicle, and workers in art, culture, recreation, and sport were most likely to commute actively.

- Associations between occupation and active commuting were different between males and females.

- Commuting by private motorized vehicle and walking declined slightly from 2006 to 2016 (relative changes of -1% and -8%, respectively, each representing absolute changes of -1%), while cycling and public transit use increased (relative changes of +14% and +12%, respectively, and absolute changes of less than 1% and 1.5%, respectively).

- Future research should further investigate the characteristics of occupations that facilitate or impede active commuting to inform effective intervention design.

Physical activity (PA) plays an important role in preventing chronic diseases and premature mortality.[1] Adults are recommended to accumulate 150 minutes of moderate-to-vigorous intensity PA per week.[2] However, most Canadian adults do not meet this recommendation.[3] Active transportation refers to using human-powered means to get around, such as walking and cycling.[4] Although public transit use is not generally considered a mode of active transportation, research has shown that individuals who use transit often cycle or walk to access transit stops, helping transit users accumulate PA.[5,6] Active transportation is also linked to physical and mental health benefits, as well as environmental health benefits because of its low carbon footprint.[7,8]

Promoting PA in workers is an important target for public health interventions since around two-thirds of Canadian adults participate in the labour force and can spend one-third of their day at work.[9] The characteristics of workers' occupation may impact their ability to engage in PA, including active transportation. For instance, work that involves long hours, high physical exertion, and high psychological demands has been associated with reduced leisure-time PA, which may be the result of fatigue, reduced motivation, or perceived lack of time.[10–13] While some occupations incur PA as part of the job, some research suggests that occupational PA may not always be health enhancing.[14,15] Previous research has also found that workers in occupations involving low PA (technical, paraprofessional, management, and professional occupations) reported the highest transportation-related PA.[16] Furthermore,

workplace facilities and policies can also support greater levels of PA, including active transportation, such as the availability of showers or change rooms and flexible work schedules.[17,18]

Active commuting (AC), using active transportation to commute to and from work, presents a practical way for workers to engage in daily PA. While AC is only one form of PA for workers, using active transportation is associated with higher levels of PA.[4] In Canada, transportation-related PA has been positively associated with device-measured moderate-to-vigorous intensity PA levels.[19] However, limited research has focused on understanding associations between different occupations and AC. Work by Foth et al. suggests public transit use may vary by occupation; however, there is little research in this area.[20] Other studies investigating specific occupational classifications and AC are often limited by small non-representative samples, have combined cycling and walking as modes of AC, or do not describe gender or sex differences.[18,21] In Canada, the distribution of occupations,[22] unpaid labour,[23,24] and rates of active transportation differ between men and women.[25] At the same time, barriers and facilitators of AC may differ between men and women.[26]

This study examined the associations between occupational classifications, part-time work, and AC (i.e., walking, cycling) and public transit use, in a nationally representative sample of Canadian adults, while controlling for other relevant sociodemographic characteristics (e.g., education, income, urbanity). This study also explored how associations between

occupational classifications and AC differed by sex and how AC rates may have changed over time.

Methods

Data source

This study used public use microdata file (PUMF) data from the three most recent and available years of the Census of Population (2006, 2011, 2016). The census is a cross-sectional, nationally representative survey of the Canadian population and is completed around early May every five years. Completing the census is mandatory by law.[27] In 2006 and 2016, 20% and 25% of households, respectively, were asked to complete the long-form census questionnaire, which, in addition to the short-form questionnaire's demographic questions, asks social, economic, and employment-related questions. In 2011, the long-form census questionnaire was replaced with the voluntary National Household Survey (NHS); however, both measures and completion rates remained similar. Henceforth, the long-form census questionnaire and NHS are referred to as the census. For each census, the PUMF contains a representative subsample (2.7%) of Canadian households, providing access to non-aggregated data that maintain the confidentiality of participants.[28–30]

Population

This study includes data from adults aged 18 years and over who self-reported participating in the workforce (for pay or in self-employment) during the previous year. Participants were excluded if they reported working from home or did not have a fixed workplace address. Although data completeness was high for all variables, individuals with missing data on any exposure variable or covariate were excluded (2006: n=18,776, 2011: n=31,339, 2016: n=44,687).

Exposure variables: Occupation and part-time working status

Census occupation refers to the individual's job held in the week before census completion (early May each census year) or the job that was held the longest since the January before if the respondent did not work that week or worked more than one job. Broad occupational categories were organized according to the National Occupation Classification (NOC). These categories were assigned by Statistics Canada based on two self-reported census questions outlining job descriptions and job tasks. Specifically, occupations were classified according to the NOC 2006 for the 2006 and 2011 Census cycles. The updated NOC 2016 was used to classify occupations for the 2016 Census cycle. Despite changes in occupational classifications between 2006 and 2016, the 10 broad occupational classifications remained the same, and a crosswalk was used to ensure comparability over time.[31] These occupational categories were (1) management; (2) business, finance, and administration; (3) natural and applied sciences and related; (4) health; (5) education, law and social, community, and government services; (6) art, culture, recreation, and sport; (7) sales and service; (8) trades, transport, and equipment operators, and related; (9) natural resources, agriculture, and related production; and (10) manufacturing and utilities. However, three categories were collapsed into a single occupational group for men and women because of small cell sizes for AC among women: trades, transport, and equipment operators and related; natural resources, agriculture, and related production; and manufacturing and utilities. They are referred to as trades, transportation, natural resources, and manufacturing. These three occupational groups consisted of similar skill profiles. More information on occupations within broad NOC categories is available elsewhere.[32]

Figure 1
Flow diagram of the study cohort by census year, with sample inclusions and exclusions
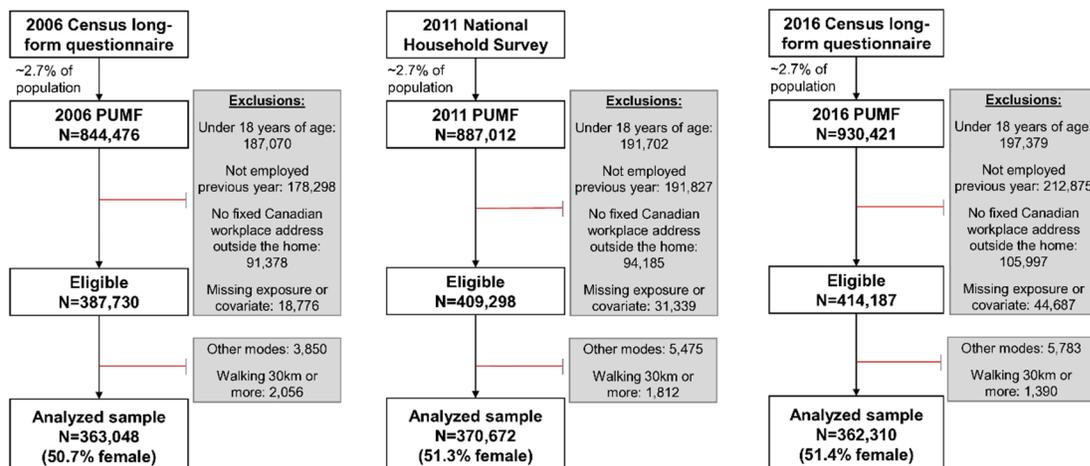
Note: PUMF = public use microdata file.
Source: Statistics Canada, authors' calculations.

Part-time work was self-reported and defined as working less than 30 hours per week compared with full-time work (30 hours or more per week). If participants worked a combination of full-time and part-time work, they reported information on the job for which they worked the most.

Outcome: Mode of commute

Census participants were asked to identify the mode of transportation used most frequently to travel between home and work, selecting from (1) walk; (2) bicycle; (3) public transit; (4) car, truck, or van as driver; (5) car, truck, or van as passenger;

(6) motorcycle, scooter, or moped; or (7) other modes. In 2006, an additional category of "taxicab" was included, but it was not provided in 2011 or 2016. This category was grouped with "other modes" and ultimately excluded from analyses. Individuals who used more than one travel mode were asked to report the mode used for most of their travel distance. For analytical purposes, the following responses were grouped into a single category of "private motorized vehicle": car, truck, or van as driver; car, truck, or van as passenger; and motorcycle, scooter, or moped. The resulting four outcome categories of walking, cycling, public transit, and private motorized vehicle were analyzed.

Table 1

Proportions and 95% confidence intervals of female workers using each mode of transportation by sociodemographic characteristics (2016)

	Proportion of overall sample			Walking			Cycling			Public transit			Private motorized vehicle		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
	Percent	from	to	Percent	from	to	Percent	from	to	Percent	from	to	Percent	from	to
Overall sample	51.4	51.3	51.5	6.4	6.3	6.5	1.1	1.0	1.1	15.3	15.2	15.5	77.2	77.1	77.4
Occupational groups															
Art, culture, recreation, and sport	2.6	2.5	2.6	8.8	8.1	9.4	3.7	3.4	3.9	20.6	19.4	21.8	67.0	65.8	68.2
Natural and applied sciences and related	3.0	3.0	3.1	4.6	4.0	5.2	2.4	2.2	2.7	22.1	20.7	23.5	70.8	69.6	72.1
Education, law and social, community, and government services	16.5	16.3	16.7	6.7	6.5	6.9	1.3	1.2	1.5	12.3	12.0	12.7	79.6	79.2	80.1
Business, finance, and administration	24.7	24.5	24.9	4.9	4.7	5.0	0.7	0.6	0.8	17.4	17.1	17.7	77.0	76.6	77.4
Sales and service	27.8	27.7	28.0	9.1	8.9	9.3	1.0	0.9	1.0	18.5	18.2	18.8	71.4	71.0	71.8
Management	8.5	8.4	8.6	5.5	5.2	5.9	1.0	0.8	1.1	11.8	11.2	12.4	81.7	80.9	82.5
Health	12.5	12.4	12.7	4.4	4.1	4.7	1.0	0.9	1.1	9.1	8.6	9.5	85.5	85.0	86.0
Trades, transportation, natural resources, and manufacturing	4.4	4.3	4.5	3.1	2.9	3.4	0.5	0.3	0.7	11.6	10.8	12.3	84.8	83.9	85.7
Weekly work hours															
Full-time (30 hours or more)	73.8	73.6	73.9	5.6	5.5	5.7	1.0	1.0	1.1	14.7	14.6	14.9	78.7	78.5	78.9
Part-time (less than 30 hours)	26.2	26.1	26.4	8.6	8.4	8.9	1.2	1.1	1.3	17.1	16.8	17.3	73.1	72.8	73.5
Distance to work															
Less than 5 km	38.8	38.5	39.0	15.4	15.3	15.6	2.2	2.1	2.3	12.7	12.5	12.9	69.7	69.5	70.0
5 km to 14 km	36.2	36.0	36.4	0.8	0.7	0.8	0.6	0.5	0.6	19.1	18.8	19.3	79.6	79.3	79.9
15 km or more	25.1	24.8	25.3	0.4	0.3	0.5	0.1	0.0	0.1	14.1	13.8	14.4	85.5	85.2	85.8
Age (years)															
18 to 24	13.5	13.3	13.7	8.5	8.2	8.8	1.5	1.3	1.6	23.9	23.4	24.4	66.2	65.6	66.7
25 to 39	31.5	31.4	31.7	6.8	6.6	7.0	1.5	1.4	1.6	17.4	17.1	17.7	74.3	74.0	74.6
40 to 54	33.8	33.6	34.0	4.9	4.7	5.0	0.8	0.7	0.9	12.2	11.8	12.5	82.1	81.8	82.5
55 and over	21.2	21.0	21.4	6.7	6.5	6.8	0.5	0.5	0.6	11.9	11.6	12.3	80.9	80.5	81.3
Marital status															
Not married or common law	37.7	37.5	37.9	8.3	8.2	8.5	1.4	1.3	1.5	21.0	20.7	21.3	69.3	69.0	69.6
Married or common law	62.3	62.1	62.5	5.2	5.0	5.3	0.9	0.8	0.9	11.9	11.7	12.1	82.1	81.8	82.3
Education															
Less than a secondary school diploma	6.9	6.8	7.0	10.2	9.8	10.7	0.5	0.4	0.7	13.8	13.3	14.3	75.4	74.8	76.0
Secondary school diploma or more	93.1	93.0	93.2	6.1	6.0	6.2	1.1	1.0	1.1	15.4	15.3	15.6	77.4	77.2	77.6
Immigrant status															
Immigrant	22.3	22.1	22.5	6.5	6.2	6.7	0.8	0.7	0.9	29.9	29.6	30.2	62.8	62.4	63.2
Non-immigrant	77.7	77.5	77.9	6.3	6.2	6.4	1.1	1.1	1.2	11.2	11.0	11.3	81.4	81.2	81.6
Population group															
South Asian	4.5	4.5	4.6	4.8	4.3	5.3	0.2	0.1	0.3	27.2	26.3	28.1	67.8	67.0	68.6
East or Southeast Asian	8.7	8.6	8.8	6.9	6.5	7.3	0.7	0.5	0.8	33.3	32.6	34.0	59.1	58.5	59.7
Black	2.7	2.7	2.8	3.5	3.0	3.9	0.2	0.1	0.3	45.0	43.8	46.2	51.3	50.1	52.6
Latin American	1.2	1.2	1.3	6.7	5.5	7.9	1.1	0.8	1.3	37.4	35.1	39.8	54.8	52.4	57.2
Middle Eastern	1.4	1.3	1.4	7.5	6.5	8.5	0.4	0.2	0.7	31.4	29.6	33.2	60.6	58.7	62.6
Multiple racialized groups	1.5	1.4	1.5	7.3	6.3	8.3	1.4	0.9	2.0	35.7	33.3	38.1	55.6	53.1	58.0
Indigenous	3.6	3.6	3.7	10.4	9.7	11.2	0.7	0.5	0.9	9.4	8.7	10.1	79.4	78.3	80.5
White, not a racialized group	76.4	76.2	76.5	6.3	6.2	6.4	1.2	1.1	1.3	10.8	10.6	10.9	81.8	81.5	82.0
Number of children under 15 years in the household															
None	71.7	71.6	71.9	7.1	7.0	7.2	1.2	1.1	1.2	16.5	16.3	16.7	75.2	75.0	75.5
One or more	28.3	28.1	28.4	4.5	4.4	4.7	0.8	0.7	0.9	12.4	12.1	12.6	82.3	82.1	82.6
Household income, annual ($)															
Less than 35,000	11.5	11.4	11.7	14.0	13.5	14.6	2.0	1.8	2.2	23.7	23.3	24.0	60.3	59.8	60.7
35,000 to 54,999	14.9	14.7	15.0	8.7	8.5	8.9	1.2	1.1	1.3	18.7	18.1	19.2	71.4	70.9	71.9
55,000 to 74,999	16.3	16.2	16.4	6.6	6.4	6.9	1.0	0.9	1.1	15.5	15.1	15.8	76.9	76.4	77.4
75,000 to 99,999	19.2	19.1	19.3	5.1	4.9	5.3	0.8	0.7	0.9	13.4	13.0	13.9	80.6	80.1	81.2
100,000 or more	38.1	37.9	38.3	3.6	3.5	3.8	0.8	0.8	0.9	12.4	12.2	12.6	83.1	82.8	83.4
Urbanity of residence															
Non-census metropolitan area	28.3	28.1	28.5	6.8	6.5	7.1	0.6	0.5	0.6	1.7	1.6	1.8	91.0	90.7	91.2
Census metropolitan area	71.7	71.5	71.9	6.2	6.0	6.3	1.3	1.2	1.3	20.7	20.6	20.9	71.8	71.6	72.1

Note: Total sample size of 186,221.

Source: 2016 Census public use microdata file, authors' calculations.

Table 2
Proportions and 95% confidence intervals of male workers using each mode of transportation by sociodemographic characteristics (2016)

	Proportion of overall sample			Walking			Cycling			Public transit			Private motorized vehicle		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
	Percent	from	to	Percent	from	to	Percent	from	to	Percent	from	to	Percent	from	to
Overall sample	48.6	48.5	48.7	5.2	5.1	5.3	2.0	2.0	2.1	11.8	11.6	12.0	81.0	80.8	81.3
Occupational groups															
Art, culture, recreation, and sport	2.2	2.1	2.2	10.3	9.4	11.3	6.7	5.8	7.6	0.1	18.4	21.8	62.8	61.0	64.7
Natural and applied sciences and related	11.3	11.2	11.4	3.9	3.6	4.2	2.8	2.6	3.1	0.1	17.5	18.9	75.1	74.3	75.8
Education, law and social, community, and government services	7.9	7.7	8.0	6.9	6.2	7.5	3.5	3.2	3.9	0.1	11.9	12.9	77.2	76.6	77.8
Business, finance, and administration	10.1	10.0	10.2	5.2	4.9	5.5	1.8	1.6	2.0	0.0	17.5	18.8	74.9	74.1	75.7
Sales and service	20.9	20.7	21.1	9.2	8.9	9.5	2.4	2.2	2.6	0.0	16.9	17.6	71.1	70.7	71.5
Management	13.3	13.1	13.4	4.8	4.6	5.1	1.4	1.3	1.6	0.1	7.3	7.9	86.1	85.7	86.6
Health	2.8	2.7	2.9	5.6	4.9	6.3	3.1	2.6	3.6	0.1	7.3	9.4	82.9	81.3	84.5
Trades, transportation, natural resources, and manufacturing	31.6	31.3	31.8	2.3	2.2	2.5	1.0	1.0	1.1	0.1	4.9	5.3	91.6	91.4	91.8
Weekly work hours															
Full-time (30 hours or more)	87.0	86.9	87.1	4.6	4.4	4.7	1.9	1.9	2.0	10.6	10.4	10.8	82.9	82.6	83.1
Part-time (less than 30 hours)	13.0	12.9	13.1	9.3	9.0	9.5	2.8	2.6	3.0	19.4	19.0	19.9	68.5	68.0	69.0
Distance to work															
Less than 5 km	32.3	32.1	32.5	15.0	14.7	15.4	4.6	4.4	4.7	10.3	10.0	10.6	70.2	69.8	70.5
5 km to 14 km	35.6	35.4	35.7	0.7	0.6	0.8	1.5	1.3	1.6	14.8	14.4	15.1	83.1	82.7	83.4
15 km or more	32.1	31.9	32.3	0.3	0.2	0.3	0.1	0.1	0.2	10.0	9.8	10.2	89.6	89.4	89.9
Age (years)															
18 to 24	13.0	12.9	13.1	8.1	7.7	8.5	2.6	2.4	2.8	19.3	18.7	19.9	69.9	69.3	70.6
25 to 39	30.9	30.8	31.1	6.3	6.0	6.5	2.7	2.5	2.8	14.5	14.1	15.0	76.5	76.0	77.0
40 to 54	32.5	32.3	32.7	3.5	3.4	3.7	1.8	1.7	1.9	9.5	9.3	9.8	85.1	84.9	85.4
55 and over	23.6	23.4	23.7	4.4	4.3	4.6	1.2	1.1	1.3	7.0	6.8	7.3	87.3	87.0	87.6
Marital status															
Not married or common law	35.2	35.0	35.4	8.1	7.9	8.4	2.6	2.5	2.8	17.0	16.6	17.5	72.2	71.7	72.7
Married or common law	64.8	64.6	65.0	3.6	3.5	3.7	1.7	1.6	1.8	8.9	8.7	9.1	85.8	85.6	86.0
Education															
Less than a secondary school diploma	10.3	10.1	10.4	6.5	6.3	6.8	1.3	1.2	1.5	8.3	7.9	8.7	83.8	83.4	84.2
Secondary school diploma or more	89.7	89.6	89.9	5.0	4.9	5.2	2.1	2.0	2.2	12.2	12.0	12.4	80.7	80.4	80.9
Immigrant status															
Immigrant	23.2	22.9	23.5	4.6	4.4	4.8	1.7	1.7	1.8	19.8	19.3	20.2	73.9	73.5	74.3
Non-immigrant	76.8	76.5	77.1	5.4	5.2	5.5	2.1	2.0	2.2	9.3	9.2	9.5	83.2	82.9	83.4
Population group															
South Asian	5.4	5.3	5.5	3.3	2.8	3.8	0.5	0.4	0.6	20.3	19.3	21.3	75.9	74.9	77.0
East or Southeast Asian	7.6	7.4	7.8	4.5	4.2	4.8	1.3	1.2	1.5	22.2	21.7	22.8	71.9	71.3	72.6
Black	2.5	2.4	2.6	3.8	3.1	4.4	0.8	0.4	1.1	32.9	31.6	34.1	62.6	61.3	63.8
Latin American	1.2	1.2	1.3	4.8	3.7	5.9	3.0	2.3	3.6	27.5	25.6	29.3	64.8	62.7	66.8
Middle Eastern	1.9	1.8	1.9	4.8	3.9	5.6	1.2	0.8	1.6	21.7	20.3	23.0	72.4	71.1	73.7
Multiple racialized groups	1.5	1.4	1.5	5.7	4.8	6.5	2.2	1.8	2.6	25.3	24.2	26.4	66.8	65.5	68.1
Indigenous	3.1	3.0	3.2	8.8	8.0	9.7	1.8	1.5	2.1	7.6	6.8	8.4	81.8	80.6	82.9
White, not a racialized group	76.8	76.4	77.1	5.3	5.2	5.4	2.3	2.2	2.4	8.8	8.7	9.0	83.6	83.4	83.8
Number of children under 15 years in the household															
None	72.6	72.5	72.8	6.1	5.9	6.2	2.1	2.0	2.2	12.4	12.1	12.6	79.5	79.2	79.8
One or more	27.4	27.2	27.5	2.9	2.7	3.1	1.9	1.8	2.0	10.1	9.8	10.4	85.1	84.7	85.5
Household income, annual ($)															
Less than 35,000	10.3	10.2	10.5	13.3	13.0	13.6	4.1	3.8	4.4	21.3	20.8	21.8	61.3	60.5	62.1
35,000 to 54,999	13.8	13.7	14.0	7.2	6.9	7.5	2.1	2.0	2.3	13.4	13.0	13.8	77.2	76.8	77.7
55,000 to 74,999	16.4	16.3	16.6	5.1	4.8	5.4	1.7	1.6	1.9	10.5	10.1	10.8	82.8	82.2	83.3
75,000 to 99,999	19.5	19.3	19.7	4.0	3.8	4.2	1.7	1.5	1.8	9.8	9.4	10.2	84.5	84.1	85.0
100,000 or more	40.0	39.7	40.2	3.0	2.9	3.1	1.8	1.7	1.9	10.2	10.0	10.5	85.0	84.7	85.2
Urbanity of residence															
Non-census metropolitan area	27.8	27.6	28.0	5.3	5.2	5.5	1.1	1.0	1.2	2.0	1.9	2.1	91.6	91.4	91.8
Census metropolitan area	72.2	72.0	72.4	5.1	5.0	5.3	2.4	2.3	2.5	15.5	15.3	15.8	76.9	76.6	77.3

Note: Total sample size of 176,089.
Source: 2016 Census public use microdata file, authors' calculations.

Covariates

The models were stratified by sex (male or female). Models controlled for the following covariates: age group (18 to 24, 25 to 39, 40 to 54, 55 and over), straight-line distance to work (less than 5 km [walkable distance], 5 km to 14 km [bikeable distance], 15 km or more[33]), education level (less than secondary school diploma, secondary school diploma or more), income (approximate quintiles: less than $35,000, $35,000 to $54,999, $55,000 to $74,999, $75,000 to $99,999, $100,000 or more), marital status (married or in common-law relationships, not married or in common-law relationships), number of children under the age of 15 years (none, one or more), immigrant status (immigrant, non-immigrant), identification as a member of a racialized group (racialized group, not a racialized group), and urbanity of residence (living in a census-defined census metropolitan area [CMA],[29] not living in a census-defined CMA). Because of small cell sizes for certain population groups, only a binary variable for racialized group could be included in models. However, larger cell sizes allowed for descriptive statistics of several racialized and cultural background groups. Additionally, given that distance to work

was estimated by Statistics Canada based on representative points (block, collection unit, or census subdivision) of home and work addresses, distances may not reflect the actual distances travelled. Individuals who reported walking distances of 30 km or more were excluded because of implausibility (less than 1% per cycle).

Statistical analysis

Proportions were used for descriptive statistics with 95% confidence intervals (CIs). Unless otherwise stated, values reported are from the 2016 Census, with values from 2006 and 2011 showing similar results. Covariate-adjusted multinomial logistic regression was used to calculate the odds ratio (OR) and 99% CI of commuting by walking, cycling, and public transit relative to private motorized vehicle (referent) for different occupational characteristics stratified by sex. First, the association of working part-time compared with full-time hours with AC was investigated using multinomial logistic regression that additionally controlled for occupational category. Second, eight multinomial logistic regression models were fitted to examine the association of working in each broad occupational category compared with all other occupations by mode of commute. Each model investigated the association of a different occupational category by AC group with an additional adjustment for part-time work. To reduce the likelihood of making a type 1 error given the repeated models, 99% CIs were calculated for all multinomial logistic regression models.

CIs for each estimate were calculated according to the variance estimation procedure described in the 2006, 2011, and 2016 PUMF user guides using replicate weights.[28-30] For a given estimate, the sample was divided into *n* representative replicates, estimates were calculated within each replicate, and variance was estimated based on differences across replicates. In instances where replicates were empty for certain covariate and outcome combinations, an estimate of 0 was assigned as outlined by the PUMF user guide. All analyses incorporated PUMF survey weights and were repeated for 2006, 2011, and 2016 Census years. All analyses were conducted using SAS 9.4. Data visualizations were conducted using R statistical software and the *ggplot2* package.

Results

The sample derivation is outlined in Figure 1. Data were analyzed for 362,310 individuals (51.4% female) from the 2016 Census, 370,672 individuals (51.3% female) from the 2011 Census, and 363,048 individuals (50.7% female) from the 2006 Census. The total sample size for the time trends analysis was 1,096,030. The most common mode of transportation to work in 2016 was private motorized vehicle (79.1%; 95% CI: 78.9% to 79.2%), followed by public transit (13.6%; 95% CI: 13.5% to 13.7%), walking (5.8%; 95% CI: 5.7% to 5.9%), and cycling (1.5%; 95% CI: 1.5% to 1.6%). In 2016, a greater proportion of females commuted by walking (female [F]: 6.4%, 95% CI: 6.3% to 6.5% versus male [M]: 5.2%, 95% CI: 5.1% to 5.3%) and public transit (F: 15.3%, 95% CI: 15.2% to 15.5% versus

M: 11.8%, 95% CI: 11.6% to 12.0%), while a greater proportion of males commuted by cycling (F: 1.1%, 95% CI: 1.0% to 1.1% versus M: 2.0%, 95% CI: 2.0% to 2.1%) and private motorized vehicle (F: 77.2%, 95% CI: 77.1% to 77.4% versus M: 81.0%, 95% CI: 80.8% to 81.3%). Walking and cycling to work were more prevalent among younger compared with older workers, among those not married or in common-law relationships compared with those married or in common-law relationships, and among those with no children compared with those with children. Additionally, walking to work was more prevalent among those with a lower household income. A greater proportion of workers walked or cycled to work if they lived less than 5 km from their workplace compared with living farther away (5 km or more). A considerable number (12.7% of females, 10.3% of males) of people who lived less than 5 km from work also used public transit. Table 1 and 2 provide the distribution of modes of transportation by occupational and sociodemographic characteristics.

Differences in mode of commute by occupation, part-time work, and sex

Figure 2 depicts the odds of walking, cycling, and using public transit compared with using a private motorized vehicle across (a) occupational groups and (b) part-time work by sex. For both sexes, AC and public transit use were highest for those in art, culture, recreation, and sport occupations. Working in these occupations was associated with a three times greater likelihood of cycling among males (OR=3.03, 99% CI: 2.36 to 3.71) and females (OR=3.12, 99% CI: 2.82 to 3.41). This occupational group was also significantly associated with greater odds of walking and using public transit. Natural and applied sciences and related occupations were also associated with increased odds of walking, cycling, and using public transit compared with driving. However, the magnitude of the association differed between males and females. Females working in natural and applied sciences and related occupations had increased odds of cycling relative to private motorized vehicle use compared with males (F: OR=3.35, 99% CI: 2.73 to 3.97 versus M: OR=1.91, 99% CI: 1.61 to 2.20). Conversely, males working in these occupations had increased odds of public transit use compared to females (F: OR=1.42, 99% CI: 1.24 to 1.61 versus M: OR=1.80, 99% CI: 1.69 to 1.91). Unadjusted ORs are available in Appendix Table A, and adjusted ORs are available in Appendix Table B.

Occupations in trades, transportation, natural resources, and manufacturing were associated with the lowest likelihood of AC relative to private motorized vehicle use. The OR of walking for females in these occupations compared with all others was 0.46 (99% CI: 0.39 to 0.52) and for males in these occupations was 0.34 (99% CI: 0.31 to 0.36). In addition, occupations in health, management, and sales and service were, in general, associated with the next lowest likelihood of AC and public transit use.

There were large sex differences within some occupational groups. For example, business, finance, and administration occupations were associated with a greater likelihood of walking, cycling, and using public transit, relative to using a

private motorized vehicle, among males compared with females (e.g., F: $OR_{walking}=0.97$, 99% CI: 0.91 to 1.03 versus M: $OR_{walking}=1.24$, 99% CI: 1.14 to 1.34). Greater likelihoods of AC among males than females were also seen for occupations in health; sales and service; and education, law and social, community, and government services. Refer to Figure 2 for sex differences in the associations between occupation and mode of commute.

Working part-time hours, compared with full-time hours, was associated with an increased likelihood of walking, among both sexes, and using public transit, among males, relative to using private motorized vehicles.

Time trends in mode of commute

Figure 3 depicts the proportion of workers using each mode of commute over time by sex. From 2006 to 2016, the share of private motorized vehicle users decreased from 77.6% (95% CI: 77.5% to 77.8%) to 77.3% (95% CI: 77.1% to 77.4%) among females (relative decrease of 0.5%) and 82.9% (95% CI: 82.8% to 83.1%) to 81.0% (95% CI: 80.8% to 81.3%) among males (relative decrease of 2.3%). Over the same time, public transit use increased among females from 14.3% (95% CI: 14.2% to 14.4%) to 15.3% (95% CI: 15.2% to 15.5%), a relative increase of 7.0%, and among males from 9.8% (95% CI: 9.7% to 9.9%) to 11.8% (11.6% to 12.0%), a relative increase of 20.0%. Among females, walking decreased from 7.2% (95% CI: 7.1% to 7.3%) to 6.4% (95% CI: 6.3% to 6.5%), a relative decrease of 8.1%. Among males, the percentage change in walking was a decrease of 3.4%, though non-significant (2016: 5.4%, 95% CI: 5.2% to 5.5%; 2006: 5.2%, 95% CI: 5.1% to 5.3%). Among females, the proportion of workers cycling increased from 0.8% (95% CI: 0.8% to 0.9%) to 1.1% (95% CI: 1.0% to 1.1%) a relative increase of 27.8%, while, among males cycling increased from 1.9% (95% CI: 1.8% to 1.9%) to 2.0% (95% CI: 2.0% to 2.1%), a relative increase of 7.9%.

Figure 4 depicts the proportion of workers using each mode of commute from 2006 to 2016 by occupation. Natural and applied

Figure 2
Adjusted odds ratios and 99% confidence intervals of commuting by walking, cycling, or using public transit relative to using a private motorized vehicle by occupational group and part-time work, stratified by sex, 2016
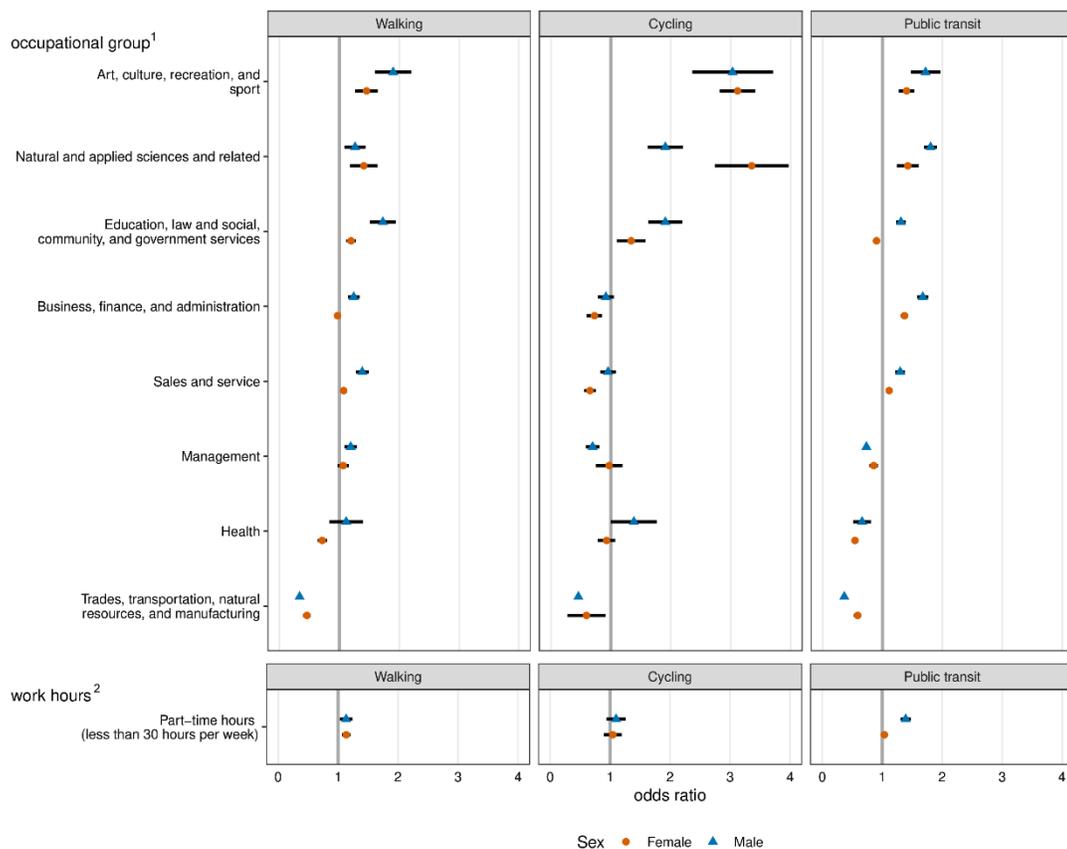
Notes:
1. Adjusted for age, commute distance, marital status, education, immigrant status, ethnic or cultural background, living with children under the age of 15 years, income, urbanity, and part-time work.
2. Adjusted for age, commute distance, marital status, education, immigrant status, ethnic or cultural background, living with children under the age of 15 years, income, urbanity, and occupational group.
Source: 2016 Census public use microdata file, authors' calculations.

sciences and related occupations, followed by art, culture, recreation, and sport occupations, saw the largest relative declines in private motorized vehicle use (-5.3% and -4.1%, respectively) and both saw large relative increases in public transit use and cycling. Trades, transportation, natural resources, and manufacturing occupations experienced a slight increase in private motorized vehicle use (+1.3%) and declines in cycling and walking. Management occupations and natural and applied sciences and related occupations experienced the largest relative increases in cycling (+58.7% and +34.6%, respectively) and were the only occupations with relative increases in walking (+5.2% and +6.0%, respectively). Sales and service occupations experienced the largest relative increase in public transit use (+24.2%).

Discussion

Summary of findings and comparisons with previous literature

This study fills an important research gap by identifying overall and sex-specific associations between occupational classifications and AC among Canadian working adults. It builds on previous research describing occupational differences in domain-specific PA, including transport-related PA.[16] This study found that working part-time and having art, culture,

recreation, and sport occupations or natural and applied sciences and related occupations were associated with an increased likelihood of AC compared with private motorized vehicle use. Occupations in trades, transportation, natural resources, and manufacturing were associated with a reduced likelihood of AC. Additionally, certain occupations were associated with a greater likelihood of walking, cycling, or using public transit, relative to using private motorized vehicles, among males compared with females: health; business, finance, and administration; and education, law and social, community, and government services. Results also suggest that, among Canadians, commuting by private motorized vehicle and walking has declined slightly over time, while public transit use and cycling have increased. Increases in public transit were more striking among males while increases in cycling were greater among females. Additionally, time trends in modes of commute differed by occupation; private motorized vehicle use declined the most for natural and applied sciences and related occupations while increasing for trades, transportation, natural resources, and manufacturing occupations.

Occupations in trades, transportation, natural resources, and manufacturing are often physically demanding.[32] Previous work has linked physically demanding occupations with lower leisure-time PA,[16,34] and high occupational PA may contribute to lower AC for workers in these occupations. This aligns with

Figure 3
Percentage of workers commuting by each mode from 2006 to 2016, stratified by sex
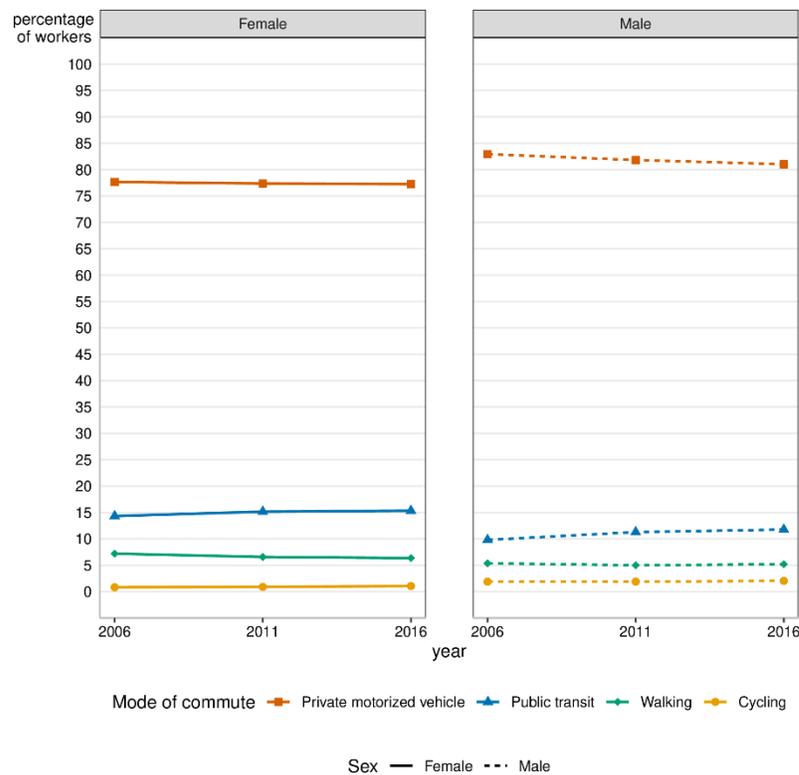
Source: 2006 and 2016 Census and 2011 National Household Survey public use microdata files, authors' calculations.

Figure 4
Percentage of workers commuting by each mode from 2006 to 2016, stratified by occupation
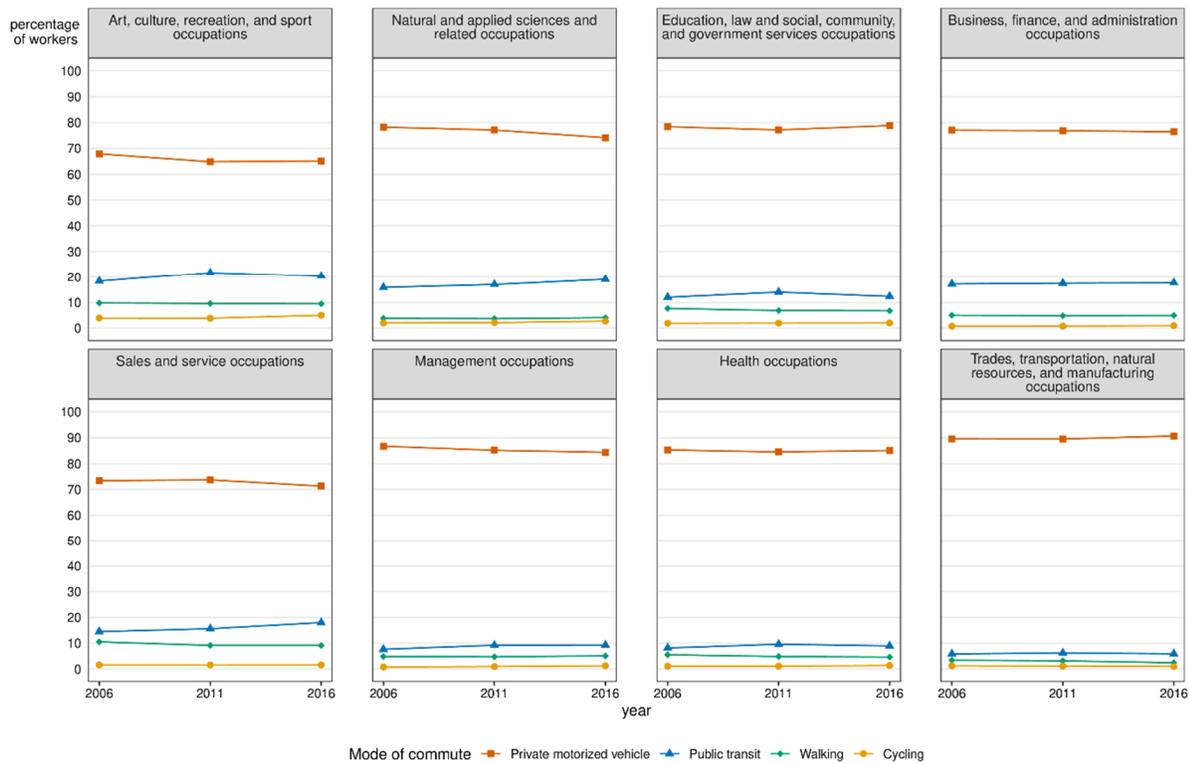
Source: 2006 and 2016 Census and 2011 National Household Survey public use microdata files, authors' calculations.

previous findings that high occupational PA, relative to low, was associated with reduced odds of AC.[35] Given the also relatively high occupational PA of health and sales and service occupations,[36] results suggest a gradient of decreasing likelihood of AC and public transit use, relative to motorized vehicle use, as occupational physical demands increase. This trend is most striking for cycling, followed by public transit and walking.

Art, culture, recreation, and sport occupations and natural and applied sciences and related occupations may be supportive of AC. It is possible that workers in some of these occupations experience greater schedule flexibility,[37] which may in turn provide them with more time for AC.[6,17] Other employer supports of AC may involve an encouraging workplace culture or access to change rooms or bike storage facilities.[17,38] Additionally, interpersonal factors such as the activities of co-workers or normative beliefs of co-workers may support AC in occupations where AC is already high.[18] On top of the employment-related factors discussed, the location of the workplace relative to the residence, the degree of telework (especially following the COVID-19 pandemic), the infrastructure supporting active transportation in the city of residence, and the neighbourhood built environment around workplaces may differ, perhaps contributing to differences in AC.[39]

Sex differences in associations between certain occupations and AC may have various explanations related to one's occupation.[26] For instance, factors of the built and social environment, including street lighting, interaction with traffic, and perceived safety, can influence women's mobility choices.[40,41] Gender biases in perceptions of professionalism associated with AC or its effects on appearance may also negatively impact AC use more greatly among women, particularly in office settings (i.e., in management and in business, finance, and administration).[42,43] Job tasks and specific occupations within broad categories may also differ by gender, and this may contribute to differences in experiences of work and workplace culture and, in turn, differences in AC.

Implications for future research and practice

Reductions in private motorized vehicle use and shifts towards AC are encouraging for public health, considering the environmental implications of driving on climate change and the health benefits of PA. Canada's first National Active Transportation Strategy, launched in July 2021, aims to increase the proportion of Canadians who use active transportation and recognizes the importance of AC for health, well-being, economic, and environmental benefits.[44] AC behaviours are complex, with multiple interrelated determinants, which may include occupational factors.[18]

Given the emphasis placed by many organizations on encouraging health promotion and wellness, the study findings provide a first step towards understanding ways in which workplace policies and environments can support workers' decision making around AC. Workplaces can be ideal settings to promote PA and behaviour change since working-aged adults can spend one-third of their day at work. Further exploration of vanguard workplaces representative of occupations associated with AC can inform how different institutional factors (e.g., greater flexibility in working hours and an organizational culture that supports health-promoting behaviours), interpersonal factors (e.g., social culture around AC), and the physical environment (e.g., perceived safety and access to workplace showers and change rooms and bicycle parking) enable or impede AC. Additionally, future research would benefit from exploring determinants of AC across different occupations, especially in those outside traditional office settings. This can inform targeted interventions that can improve the capacity of workplaces wanting to implement strategies to promote healthy behaviours and AC among their workforce and generate information that more clearly explains the drivers of promoting AC in the workforce.

Strengths and limitations

This study has several strengths. Firstly, by using census data with PUMF replicate weights, this study analyzes a population-representative sample of Canadian workers. This study also separates walking and cycling outcomes since they are unique modes of AC and stratifies the analyses by sex, providing initial insights into potential sex and gender differences. Lastly, the use of three census years enables an exploration of trends in AC. The study also has limitations. The first is the potential for heterogeneity within each broad occupational category. The broad occupational categories are based on the type, sector, and required training and experience of work performed within an occupation. However, there is potential for each broad occupational category to have different physical and psychological demands, possibly increasing within-group variability and reducing between-group variability. Without more detailed occupation data, this study was unable to directly explore associations between occupational task differences (e.g., occupational PA, psychological work demands) and AC. Additional limitations include the inability to study variations across cities with different policies or control for detailed environmental factors such as neighbourhood density, traffic speeds and volumes, cycling and pedestrian infrastructure, and public transit availability, which are associated with AC and public transit use.[33,39,45] Additionally, because of the absence of gender-related variables in the census years explored, gender differences could not be directly measured. However, the observed sex differences may relate to differences in socially constructed roles and identities of gender in PA and occupations. The 2021 Census includes a measure of gender, which will help to further explore gender-related factors. A final limitation of this study is the inability to capture multimodal transit, which includes the use of more than one mode of travel to get to the workplace as either a single mode (e.g., walk some days and drive others) or as part of the same trip (intermodality; e.g., walking to and from light trail transit to get to the workplace).

Conclusion

Overall, these findings suggest that there are occupational and sex differences in modes of commute, and these may have important implications for public health (e.g., targeted interventions for certain occupational groups and genders), workplace policies (e.g., flexibility in work hours; creation of change room, shower, and bicycle storage facilities), and transportation planning (e.g., increased creation of infrastructure to support AC). Further research aimed at understanding occupational barriers and facilitators of AC may inform interventions to support AC.

Appendix Table A

Unadjusted odds ratios and 99% confidence intervals of commuting by walking, cycling, or using public transit relative to using a private motorized vehicle by occupational group and part-time work, stratified by sex, 2016

	Walking						Cycling						Public transit					
	Female			Male			Female			Male			Female			Male		
	Odds ratio	99% confidence interval		Odds ratio	99% confidence interval		Odds ratio	99% confidence interval		Odds ratio	99% confidence interval		Odds ratio	99% confidence interval		Odds ratio	99% confidence interval	
		from	to		from	to		from	to		from	to		from	to		from	to
Occupation relative to all other workers																		
Art, culture, recreation, and sport	1.61	1.45	1.77	2.64	2.27	3.02	4.28	3.82	4.73	4.52	3.53	5.51	1.57	1.41	1.73	2.25	1.92	2.58
Natural and applied sciences and related	0.79	0.66	0.91	0.80	0.71	0.89	2.62	2.14	3.10	1.59	1.39	1.79	1.60	1.41	1.78	1.81	1.72	1.90
Education, law and social, community, and government services	1.03	0.96	1.09	1.43	1.25	1.61	1.30	1.08	1.52	1.96	1.69	2.22	0.75	0.71	0.78	1.12	1.05	1.18
Business, finance, and administration	0.71	0.67	0.75	1.10	1.01	1.18	0.60	0.49	0.71	0.93	0.79	1.08	1.19	1.14	1.25	1.79	1.69	1.89
Sales and service	1.90	1.81	2.00	2.63	2.43	2.82	0.98	0.83	1.13	1.49	1.29	1.70	1.46	1.41	1.52	1.97	1.88	2.06
Management	0.81	0.74	0.88	0.85	0.78	0.93	0.85	0.65	1.04	0.63	0.52	0.73	0.71	0.65	0.76	0.57	0.54	0.60
Health	0.59	0.53	0.65	1.06	0.86	1.27	0.83	0.70	0.97	1.50	1.12	1.88	0.50	0.46	0.53	0.69	0.55	0.83
Trades, transportation, natural resources, and manufacturing	0.44	0.39	0.49	0.30	0.27	0.32	0.40	0.19	0.61	0.34	0.32	0.37	0.68	0.61	0.74	0.28	0.27	0.30
Work hours relative to full-time work (30 hours or more per week)																		
Part-time (less than 30 hours per week)	1.67	1.59	1.75	2.45	2.30	2.59	1.25	1.08	1.42	1.75	1.54	1.96	1.25	1.21	1.28	2.22	2.13	2.30

Source: 2016 Census public use microdata file, authors' calculations.

Appendix Table B

Adjusted odds ratios and 99% confidence intervals of commuting by walking, cycling, or using public transit relative to using a private motorized vehicle by occupational group and part-time work, stratified by sex, 2016

	Walking						Cycling						Public transit					
	Female			Male			Female			Male			Female			Male		
	Adjusted odds ratio	99% confidence interval		Adjusted odds ratio	99% confidence interval		Adjusted odds ratio	99% confidence interval		Adjusted odds ratio	99% confidence interval		Adjusted odds ratio	99% confidence interval		Adjusted odds ratio	99% confidence interval	
		from	to		from	to		from	to		from	to		from	to		from	to
Occupation relative to all other workers[1]																		
Art, culture, recreation, and sport	1.45	1.26	1.64	1.90	1.60	2.20	3.12	2.82	3.41	3.03	2.36	3.71	1.40	1.27	1.53	1.72	1.47	1.97
Natural and applied sciences and related	1.41	1.18	1.64	1.26	1.08	1.44	3.35	2.73	3.97	1.91	1.61	2.20	1.42	1.24	1.61	1.80	1.69	1.91
Education, law and social, community, and government services	1.20	1.11	1.28	1.73	1.51	1.94	1.34	1.10	1.58	1.91	1.63	2.19	0.90	0.86	0.94	1.31	1.22	1.39
Business, finance, and administration	0.97	0.91	1.03	1.24	1.14	1.34	0.72	0.60	0.85	0.92	0.78	1.05	1.37	1.30	1.43	1.67	1.58	1.77
Sales and service	1.07	1.01	1.13	1.38	1.27	1.49	0.65	0.55	0.75	0.95	0.82	1.08	1.11	1.07	1.15	1.30	1.22	1.37
Management	1.06	0.97	1.16	1.19	1.08	1.29	0.97	0.75	1.19	0.69	0.58	0.81	0.85	0.78	0.93	0.73	0.69	0.77
Health	0.71	0.64	0.79	1.11	0.83	1.39	0.93	0.78	1.07	1.38	1.00	1.77	0.54	0.50	0.58	0.66	0.51	0.81
Trades, transportation, natural resources, and manufacturing	0.46	0.39	0.52	0.34	0.31	0.36	0.59	0.27	0.91	0.46	0.42	0.49	0.58	0.52	0.65	0.36	0.34	0.38
Work hours relative to full-time work (30 hours or more per week)[2]																		
Part time (less than 30 hours per week)	1.14	1.07	1.21	1.13	1.03	1.24	1.04	0.90	1.19	1.10	0.94	1.26	1.04	1.00	1.08	1.39	1.31	1.48

1. Adjusted for age, commute distance, marital status, education, immigration, ethnic or cultural background, living with children under the age of 15 years, income, urbanity, and part-time work.

2. Adjusted for age, commute distance, marital status, education, immigration, ethnic or cultural background, living with children under the age of 15 years, income, urbanity, and occupational group.

Source: 2016 Census public use microdata file, authors' calculations.

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