Impacts of commute mode on body mass index: A longitudinal analysis before and during the COVID-19 pandemic

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ABSTRACT

COVID-19 has impacted millions of commuters by decreasing their mobility and transport patterns. While these changes in travel have been studied, less is known about commute changes and their impact on individuals' body mass index (BMI). The present longitudinal study explores the relationship between BMI changes of employed individuals and commute mode in Montreal, Canada using panel data drawn from two waves of the Montreal Mobility Survey (MMS) conducted before and during the COVID-19 pandemic (n = 458). BMI was modeled separately for women and men as a function of WalkScore, commuting mode, sociodemographic, and behavioral covariates using a multilevel regression modeling approach. For women, BMI significantly increased during the COVID-19 pandemic, while telecommuting frequency, and more specifically telecommuting as a replacement of driving, led to a statistically significant decrease in BMI. For men, recreational physical activity and walkability at home decreased BMI, while telecommuting did not have a statistically significant effect on BMI. These findings confirm previously observed gendered differences in the relation between the built environment, transport behaviors, and BMI, while offering new insights regarding the impacts of the changes in commute patterns due to the COVID-19 pandemic. Since some of the COVID-19 impacts on commute are expected to be lasting, findings from this research can be of use by health and transport practitioners as they work towards generating policies that improves individuals health.

Keywords: Transport, Commute mode, COVID-19, BMI, Telecommuting, Walkability.

1 INTRODUCTION

The COVID-19 pandemic has impacted societies around the world since its onset in late 2019. To slow the spread of COVID-19 governments adopted various policies, such as lockdowns and stay-at-home orders, which led to radical changes in mobility and transport patterns. In Canada, lockdowns were implemented throughout the country, which led to schools and workplaces to either temporally shutdown or move online (*1*). Overall, the pandemic has directly reduced commuting by favorizing remote activities, with 40% of Canadian workers telecommuting in April 2020 (*2*). Teleworking remained restricted to specific types of jobs with many front-line and essential workers (e.g., healthcare, transport, construction, retail, or hospitality) remaining in-person (*1*).

Previous research on telecommuting has asserted that it has both positive benefits and negative consequences for one's health. Telecommuting has been associated with a healthier work life balance and emotional well-being, as well as increases in public and active transit usage (*3*). Yet, telecommuting has also been associated with loneliness (*3*), as well as increased stress and overwork (*4*). The effects of telecommuting on one's health are therefore varied and not fully understood both prior to and during COVID-19.

As such, this paper seeks to understand how the health of employed Canadians – as modeled through Body Mass Index (BMI) - was affected by commute changes that happened during the COVID-19 pandemic. While telecommuting is the primary exposure variable of this study, the impact of the built environment around the home on BMI is also considered as variables such as walkability and access to amenities have been routinely linked to lower BMIs (*5-7*). Using a panel data from the Montreal Mobility Survey (MMS) (n = 458), this paper examines how the modal shift to telecommuting, as well as the neighborhood-built environment, affects BMI. In doing so, we aim to contribute to the literature on the indirect health impacts of the COVID-19 pandemic on individuals.

2 LITERATURE REVIEW

Individual health is influenced by a plurality of determinants amongst which are environmental conditions, social circumstances, and behavioral patterns (*8*). In recent years, planners and policymakers have been focusing more on improving the built environment and promoting healthier behaviors of urban residents to improve population-wide health (*9*). BMI - calculated by dividing one's weight in kilograms by their height in meters - is amongst the most commonly used measures in public health to quantify overall population health (*10; 11*). BMI has been used in medicine and research as it is correlated with body mass fat and is easily employed as a measure of obesity at the population level (*10; 11*). High (35 >) BMIs have been consistently linked to elevated mortality and chronic illnesses (*11; 12*). Still, research has revealed that the validity of this measure varies across age, gender, and ethnicity (*13*), and cannot discriminate between body fat and lean mass, resulting in athletes and muscular individuals diagnosed as obese (*14; 15*). Therefore, having a high BMI on its own does not mean that an individual is at a higher risk of mortality or chronic diseases, meaning that other tools are needed to complete the diagnosis. Whilst BMI can be used to show general trends in population health.

The built environment, particularly the walkability of a neighborhood, has shown to have a statistically significant relationship with BMI. Walkability is a measure of local access to amenities (e.g., grocery stores, public transport, jobs, and other services), connectivity, land-use density, and perceptions of safety and comfort on the street (*16-19*). Accessibility by walking – a subcomponent of walkability - has been a common variable used in relation to BMI with past research linking increases of it at the neighborhood level with lower BMIs in adults (*20*). In Canada, pedestrian accessibility was found to promote and sustain elevated levels of walking for utilitarian purposes in urban areas (*5; 6*). Specifically, in Montreal, living in a walkable area was shown to slow age-related weight gain in men (*7*). Additionally, accessibility to healthy food choices is particularly important regarding BMI as it influences eating behaviors (*21-23*). Overall, the built environment's association with BMI has shown to be mediated by its ability to dictate individuals' range of choices regarding both physical activity and eating habits, resulting in population-level changes in health.

The relationship between transport patterns and health outcomes – including BMI – has been widely studied in the public health scholarship (*4; 24; 25*). Past research has highlighted the beneficial impact of active transport (i.e., walking and cycling) on health as it increases physical activity levels (*26; 27*) and has been shown to promote a decrease in BMI (*28; 29*). Public transport usage has also been associated with higher physical activity and lower BMIs as it encourages active transport to and from transit stops (*30-34*). The distance walked to public transport has been shown to help transit users fulfill the recommended daily amount of physical activity across multiple North American cities (*31; 32; 34; 35*). In contrast, private motorized transport has been associated with higher BMIs across multiple contexts (*36-38*).

While the built environment and transport patterns have effects on individual behaviors and BMI, socioeconomic and demographic characteristics are also important determinants of health which can contribute heavily to explaining population BMI patterns. Past research has highlighted that social capital - which is shaped primarily by interpersonal relationships - have the potential to influence BMI in both positive (*39*) and negative ways (*40*). In Canada, past scholarship has highlighted the protective effect of recent international immigrants' pre-immigration lifestyle on their health, leading to lower BMI values (*7; 41*). Gender has also been shown to be an important variable in BMI studies as men tend to have higher BMIs on average than women (*10; 13*), and gendered interactions with other variables have been observed (*7; 39*). Previous studies have also found that BMI increased with age, with this relationship being subject to variations depending on other individual and environmental factors (*42-44*). Lastly, for adults with high (>30) and extremely low (<18.5) BMIs, their BMI represented a higher risk for disabilities (*12; 45*).

In addition to the multiple factors already discussed, changes at the societal level can impact individuals' health. This is the case of the COVID-19 pandemic and the associated public policies which have been linked to primarily negative effects on BMI through deterioration of eating habits and decrease in physical activity in two cross sectional studies (*46; 47*). The COVID-19 pandemic forced a large segment of the working population to telecommute due to lockdowns. Before the pandemic, telecommuting in the USA has been linked to increases in active transport and physical activity, as well as increases in work-life balance (*3*) and positive impacts on general health (*48*). A 2020 review of global scholarship on telecommuting revealed that these positive effects were related to organizational skills (*49*). Telecommuting was found to be associated with social isolation and unhealthy eating habits in Japan (*50*) as well as increased sedentary time (*51*).

It is clear that the impacts of increased telecommuting during the COVID-19 pandemic had mixed effects on the population health. Whilst the studies observing BMI were of a cross sectional nature making it hard to confirm or decline any relation to the COVID-19 pandemic and the increased telecommuting. It is important to note that the effects of conventional telecommuting (i.e. before the pandemic) on telecommuting are not clearly recognized either due to sparse research. It is important to note that research on the effects of the built environment, behavioural choices, and sociodemographics on BMI have been explored extensively, yet the impacts of these variables on BMI during the COVID-19 pandemic is still in its infancy. Therefore, this paper seeks to contribute to the transport and public health literature by exploring the effects of the increases in telecommuting during the COVID-19 pandemic on individuals' health as modeled through BMI using a longitudenal data approach.

3 DATA AND METHODS

3.1 Survey tool

This study uses panel data collected through two-waves of the Montreal Mobility Survey (MMS). The MMS is a multi-year survey conducted by the Transportation Research at McGill (TRAM). MMS collects data on travel behaviors and transport perceptions in addition to sociodemographic, economic, and physical characteristics. Following Dillman, Smyth and Christian (*52)*, multiple recruitment methods were applied during both waves to ensure a large and representative sample. Half of the survey participants were first recruited through a marketing company, with the other half being recruited through a social-media advertising campaign, with fliers distributed randomly at houses in the areas near the projects and through invitation emails sent to various mailing lists in the region. The first wave of the MMS, conducted in Fall 2019 (pre-COVID-19 pandemic), had 3,533 valid respondents while the second wave, collected in Fall 2021 (during the COVID-19 pandemic), had 4,063. Of the valid respondents in wave 1, 1,541 provided responses in wave 2 after being re-contacted through an invitational email.

Both waves underwent the same data cleaning process to ensure consistency. Exclusion criteria used included time spent responding to the survey, identical e-mail or IP address within a given wave, invalid age and height changes between waves as well as having a home, work, or school location outside the Montreal CMA. Following this process, a panel of 870 respondents with valid survey responses in both waves was left for analysis. Through the two waves, we collected information on pre-pandemic and current behavior, allowing us to examine the effects of COVID-19 on commuting and health. In order to have a consistent sample through which these relationships could be evaluated, multiple filters were applied to the panel data (Figure 1). First, due to a low representation of people identifying as non-binary (n = 21), only responses given by women and men in the sample were analyzed, with other gender identities filtered out. Additionally, due to the impact of pregnancy on women's BMI, women that had children under the age of 6 in either 2019 or 2021 (either wave), and were of reproductive age (18 to 45 years old) were filtered out (n = 36). To specifically look at the impact of commuting mode on BMI, respondents were further filtered to include only those who were employed during both waves. This resulted in a final sample of 196 women and 262 men.

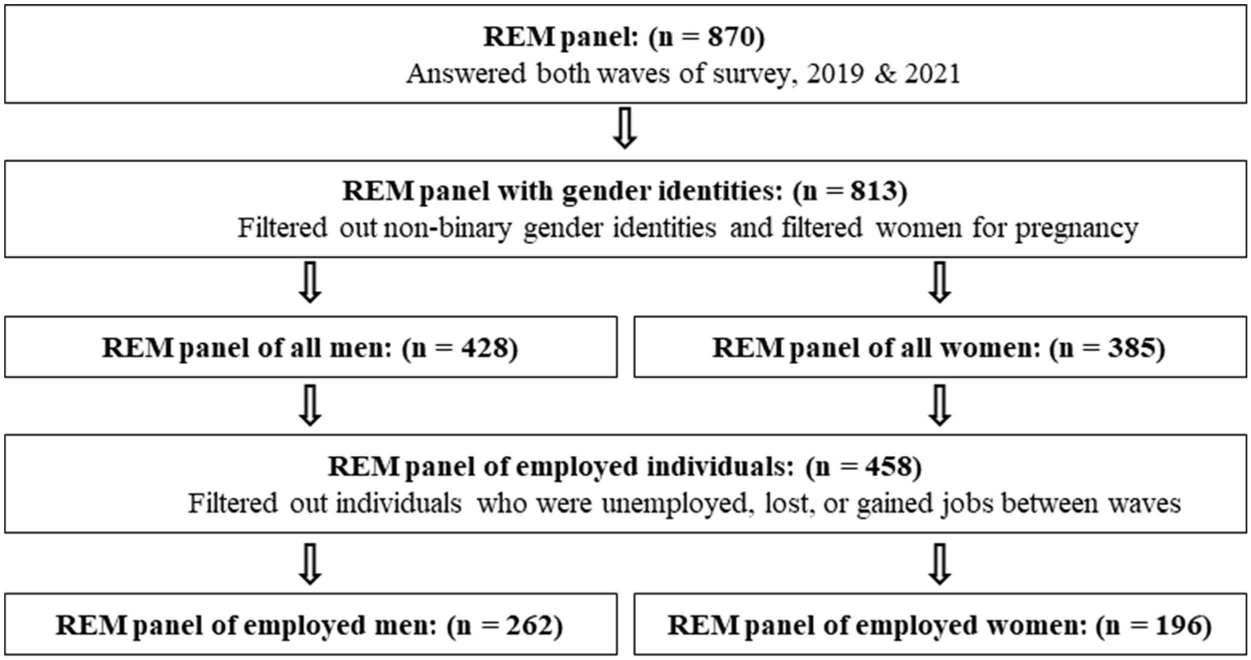

Figure 1. Data filters used to derive the analytical sample

3.2 Measures/variables

The outcome measure in this study is the BMI. BMI is calculated by dividing one's weight in kilograms by their height in meters squared, both of which were variables collected for respondents in both waves. For the models, BMI is treated as a continuous variable, and the sample's was found to be BMI normally distributed for both women and men.

The primary exposures of interest in this study are WalkScore and telecommuting frequency. WalkScore is a composite index ranging from 0 to 100 that reflects the distance to amenities by walking. This measure of local accessibility has been tested repeatedly in the land use and transport literature (*53*), showing reliability as a walkability indicator (*54*). It was collected in both waves of the survey for all respondents' home location. For modelling, we subdivided the WalkScore values into quartiles, following the methodology used in a previous study set in Montreal (*7*). For the Greater Montreal Area, these four quartiles subdivide into: low-walkable neighborhood (0-39), low-medium-walkable neighborhood (40-55), medium-high-walkable neighborhood (56-69), and high-walkable neighborhood (70-100). Telecommuting was defined as working from a remote location, such as one's home or a café rather than commuting to one's primary work location. Number of days telecommuted per week (0-7) were then recorded for each respondent that mentioned partaking in this practice. Furthermore, respondents were asked in both waves for their main mode of commuting to work which was recorded as either car, active (cycling or walking) or transit commutes.

Additionally, each of our models controlled for individual socioeconomic characteristics (age, income, education, ethnicity, marital status, disability, having children, and immigration status), individual behaviors (vigorous sport days), and perceptions of one's own health (life satisfaction with one's general health).

3.3 Analysis

To understand the factors influencing BMI levels during the COVID-19 pandemic, we estimated two sets of weighted multi-level linear regressions with BMI as the dependent variable using the lme4 R package (*55*). As in previous studies (*7; 39*), each set of models was stratified by gender, estimating one model for the women sample and one for men, given that women and men have shown differences in factors affecting their BMI. For the first set of models, the main purpose was to analyze the effect of telecommuting and local accessibility on BMI levels for women and men. For this purpose, as mentioned above, we included weekly telecommuting frequency and home-location WalkScore as the main independent variables in our model while controlling for sociodemographic and health perception. In our second set of models segregated by gender, we inquired further into the specific effects of telecommuting on BMI levels depending on the transport mode that the telecommute was replacing. This allows to analyze the interaction between telecommuting frequency and transport mode use previous to incurring in telecommuting during COVID-19.

In both set of models, we tested variables concerning individual behaviours such as active transport and work activity, and residential self-selection factors. However, these factors were excluded from both sets of models, as they were not statistically significant and did not increase the fit of the model. However, while income is not statistically significant, it was still included in both sets of models as it increases in the marginal and conditional R-squared.

To account for the two-wave panel structure of our data, both of our model sets use a two-level approach, with the individual-level as higher level, and the individual-wave-level as lower level. In this sense, the dataset is introduced in its long format, meaning that each row represents one time point per individual. Thus, the models' person-level random effects control for the fact that observations in the two waves can correspond to the same individual. Additionally, all models were weighted to ensure that the results are not biased by over- or underrepresented groups within our sample. The weights were calculated for all valid responses in the panel using the anesrake R package (*56*) to match our sample to census tract information of age, income, and gender from Statistics Canada 2016 census (*57*), retrieved through the cancensus R package (*58*).

4 RESULTS

4.1 Descriptive statistics

Table 1 presents a description of our sample in terms of their sociodemographic characteristics and modelling variables. Figure 2 presents the geographical location of our sample of 458 employed women and men in the Montreal CMA. Our descriptive analysis reveals that the average BMI for both women and men, in both waves, is in the overweight category (BMI 25-30). Among the 196 women in the sample, their mean BMI was 26.2 (SD = 5.9) in year 2019, which slightly increased to 26.6 (SD =6.4) in 2021. The proportion of employed women who were overweight or obese (BMI > 25) in 2019 was 48% and increased to 50% in 2021. Among the 262 men in the sample, their mean BMI was 27.1 (SD = 5.1) in 2019 and remained at the same value (SD = 5.5) in 2021. The proportion of employed men who were overweight or obese in 2019 (BMI > 25) was 66% and decreased to 64% in 2021.

In terms of commuting modes in year 2019, pre-COVID-19, 35% and 43% of women and men, respectively, telecommuted at least one day per week. This increased to 62% for women, and

65% for men in 2021, during the COVID-19 pandemic. In terms of traditional commutes, in year 2019 women and men most frequently commuted via public transit at 48% and 41%, respectively. In year 2019, they were similarly likely to use a car (29% for women, 31% for men), yet men were more likely to use active travel (17%) than women (13%). In year 2021, during COVID-19, both women and men considerably reduced their use of public transit, to 16% and 17% respectively. In comparison, the percentage of women and men using car or active travel to commute remained static compared to pre-pandemic levels.

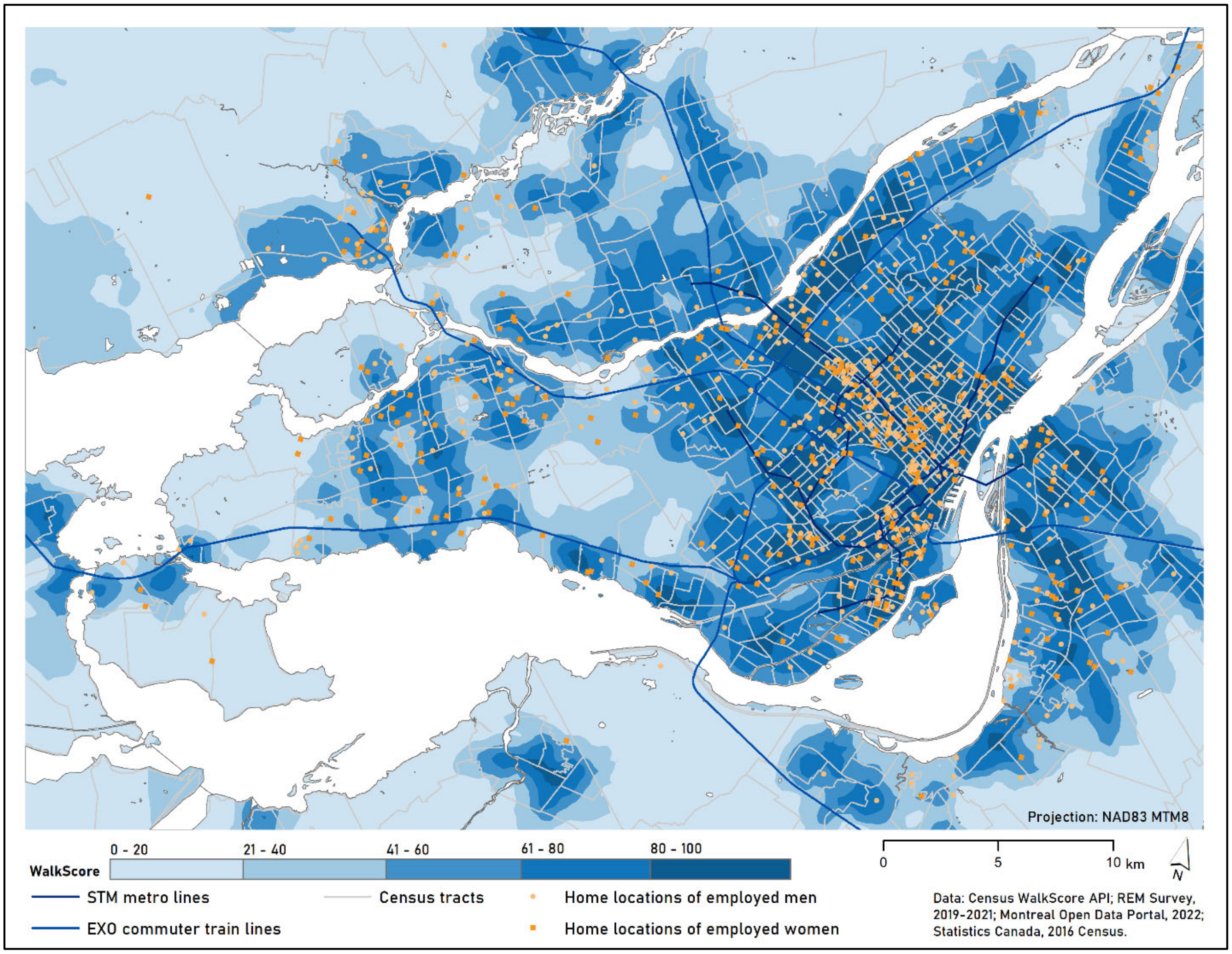

Figure 2. Context map of study area: neighborhood WalkScore and home location of survey respondents

Table 1. Characteristics of employed women and men by survey wave

			Wave 1 (2019)		Wave 2 (2021)	
Variable	Variable Explanation		**Women** Mean (SD) or %	**Men** Mean (SD) or %	**Women** Mean (SD) or %	**Men** Mean (SD) or %
Body mass index (BMI)	Weight (kg) divided by height (m^2)	*[12-65]*	26.2 (5.9)	27.1 (5.1)	26.6 (5.2)	27.1 (5.5)
Age	Years, at baseline	*[18-90]*	41 (12.8)	44 (11.8)	41 (12.8)	44 (11.8)
Average WalkScore of home location	Assigned WalkScore API of home location	*[0-100]*	59 (27.1)	57 (27.7)	58 (27.0)	58 (27.3)
Ethnicity, Caucasian	Identifies as Caucasian.	*[1 = yes, %]*	84	83	87	85
Immigration Status	Born in Canada.	*[1 = yes, %]*	78	70	78	70
Marital status	Is married.	*[1 = yes, %]*	48	65	49	67
Has children	Has children under the age of 18.	*[1 = yes, %]*	20	38	19	36
Completed postsecondary education	Education-level is undergraduate or graduate degree.	*[1 = yes, %]*	71	73	78	76
Disability	With a disability (temporary or permanent) that limits one's mobility.	*[1 = yes, %]*	7	10	11	12
Transportation disability	Daily transportation needs are affected by one's disability.	*[1 = yes, %]*	4	4	7	6
Income	Sorted into six income brackets of income in CAD	*[1 = yes, %]*				
	($):		6	5	3	3
	0-30,000		24	20	15	15
	30,001-60,000		27	18	28	21
	60,001-90,000		18	22	25	17
	90,001-120,000		13	13	12	20
	120,001-150,000		11	22	16	25
	150,001+					
Life satisfaction of general health	Satisfaction of own life and personal circumstances, specifically of one's general health.	*[0-10]*	7.4 (2.0)	7.3 (1.9)	7.0 (1.9)	7.0 (1.9)
Physical activity	Weekly days of vigorous sports	*[0-7]*	1.5 (1.7)	1.4 (1.9)	1.2 (1.6)	1.2 (1.7)
Telecommute	Weekly days of tele-commuting	*[0-7]*	0.5 (1.2)	0.7 (1.4)	2.4 (2.2)	2.7 (2.2)
Telecommuter	Telecommutes at least one day per week	*[1 = yes, %]*	35	43	62	65
Main mode of commute	Type of commute mode:	*[1 = yes, %]*				
	Car – individual vehicle, rideshare, taxi.		29	31	28	27
	Active – bike, walk, Bixi (paid bikeshare).		13	17	14	16
	Transit – metro, bus, commuter rail, paratransit.		48	41	16	17

Note. 1 SD = standard deviation.

4.2 Modelling results

The results for both sets of statistical models for women and men are exhibited in Table 2, in which the dependent variable is the individual's BMI. The first set of models' results indicate that, when keeping all other variables constant, women's BMI increased by 0.62 kg/m² (95% C.I.= 0.21 – 1.02) between 2019 and 2021. In contrast for men, when keeping all else constant, there was no significant change between survey waves. Age showed a significant effect in both women and men, with each additional year of age resulting in a 0.08 kg/m² (95% C.I. = 0.01 – 0.15) increase in BMI for women and a 0.11 kg/m² (95% C.I. = 0.06 – 0.16) increase for men. Recreational physical activity showed to decrease BMI significantly only on men by -0.22 kg/m² (95% C.I. = -0.42 – -0.01). While there is no statistically significant difference in BMI between immigrant and non-immigrant women, men born in Canada have a BMI of 1.38 kg/m² (95% C.I. =0.27 – 2.25) higher than immigrant men. Women that reported to have a disability which affects their transport needs have an increase in BMI of 1.55 kg/m² (95% C.I. = 0.09 – 3.01), whereas men with disabilities show no significant increase in BMI. Furthermore, having a positive life satisfaction of general health was negatively associated with BMI, at -0.28 kg/m² (95% C.I. = -0.44 – -0.11) for women and -0.62 kg/m² (95% C.I. = -0.81 – -0.42) for men.

In terms of the independent variables of focus in this study, telecommuting frequency and local accessibility, our first set of models shows differing results by gender. First, in terms of telecommuting, women had a reduction in BMI of 0.16 kg/m² (95% C.I.= -0.26 – -0.03) for each additional weekly telecommuting day. In contrast, there was no statistically significant effect of telecommuting frequency on men's BMI. Local accessibility showed no statistically significant effect on women's BMI. However, for men, each WalkScore quartile higher than the base group of scores 0-39, BMI decreased by 1.41 ~ 2.13 kg/m², all of which were statistically significant at a 95% confidence level, while keeping all other variables constant at their mean.

Our second set of models (Model 2) inquires deeper into the effect of telecommuting frequency on BMI levels, depending on the commuting mode that was replaced by working remotely. While all other variables in the model present nearly identical effects on BMI, segregating telecommuting by replaced mode presents interesting insights. For women, we can corroborate that telecommuting only has an effect of decreasing BMI when it is replacing commuting by private vehicle, with a decrease of 0.45 kg/m² (95% C.I.= -0.88 – -0.02) for each additional weekly telecommuting day. However, when telecommuting replaces women's commute by transit or active modes there is no statistically significant effect on BMI. For men, telecommuting has no statistically significant effect on BMI regardless of the commuting mode being replaced.

In the random effects' results, both set of models show that the between-level variance is considerably higher than the within-level variance for both women and men. This means that most variability in BMI occurs at the person level rather than between waves, which is expected given that one person's BMI in wave 2 of the survey is strongly dependent on the same person's BMI in the first wave, especially since we are considering at a gap of only two years.

Table 2. Body Mass Index associated with neighborhood walkability and commute, estimated through random-coefficient models: REM survey, Montreal, Canada, 2019-2021

	Body mass index, kg/m²							
	Model 1				Model 2			
	Women		Men		Women		Men	
Variable	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
(Intercept)	24.31***	20.72 – 27.90	26.50***	23.43 – 29.57	23.77***	20.15 – 27.39	26.53***	23.45 – 29.61
Wave 2 (Year 2021)	0.62**	0.21 – 1.02	-0.39	-0.87 – 0.09	0.37*	0.03 – 0.70	-0.19	-0.58 – 0.21
Age (at baseline, 2019)	0.08*	0.01 – 0.15	0.11***	0.06 – 0.16	0.08*	0.01 – 0.15	0.11***	0.06 – 0.16
Physical activity								
Weekly days of vigorous sports	-0.04	-0.22 – 0.15	-0.22*	-0.42 – -0.01	-0.03	-0.21 – 0.15	-0.22*	-0.43 – -0.02
Non-immigrants	0.84	-0.96 – 2.63	1.38*	0.27 – 2.50	0.93	-0.89 – 2.74	1.33*	0.21 – 2.45
Transportation disability	1.55*	0.09 – 3.01	0.58	-1.07 – 2.23	1.48*	0.02 – 2.94	0.39	-1.27 – 2.05
Income bracket								
30,001-60,000	0.38	-0.79 – 1.56	0.42	-0.93 – 1.77	0.67	-0.51 – 1.85	0.56	-0.81 – 1.93
60,001-90,000	0.59	-0.67 – 1.85	0.05	-1.36 – 1.45	0.99	-0.25 – 2.23	0.24	-1.20 – 1.67
90,001-120,000	0.17	-1.10 – 1.44	1.40	-0.11 – 2.92	0.48	-0.79 – 1.74	1.60*	0.07 – 3.13
120,001-150,000	0.35	-1.09 – 1.79	0.90	-0.76 – 2.56	0.66	-0.77 – 2.08	1.11	-0.57 – 2.78
150,001+	-0.29	-1.71 – 1.13	0.51	-1.14 – 2.15	-0.12	-1.54 – 1.30	0.72	-0.93 – 2.38
Life satisfaction								
Of general health	-0.28**	-0.44 – -0.11	-0.62***	-0.81 – -0.42	-0.23**	-0.40 – -0.06	-0.63***	-0.82 – -0.43
WalkScore quartile								
Quartile 2 (scores 40-55)	0.04	-0.95 – 1.02	-2.13***	-3.28 – -0.99	-0.11	-1.09 – 0.86	-2.09***	-3.24 – -0.94
Quartile 3 (scores 56-69)	0.37	-0.78 – 1.52	-2.13**	-3.39 – -0.87	0.32	-0.83 – 1.47	-2.09**	-3.36 – -0.83
Quartile 4 (scores 70-100)	-0.89	-1.97 – 0.19	-1.41*	-2.55 – -0.27	-0.92	-2.00 – 0.16	-1.38*	-2.52 – -0.23
Commuting mode								
Weekly days telecommuted	-0.16**	-0.29 – -0.03	0.11	-0.04 – 0.27				
Telecommutes replacing car					-0.45*	-0.88 – -0.02	0.05	-0.26 – 0.36
Telecommutes replacing active					-0.17	-0.51 – 0.16	-0.19	-0.55 – 0.18
Telecommutes replacing transit					0.16	-0.11 – 0.43	-0.03	-0.34 – 0.27
Random Effects								
σ^2 (within variance)	2.12		3.56		2.1		3.61	
τ_{00} Individuals (between variance)	32.33		16.65		32.93		16.53	
Inter-class correlation	0.94		0.82		0.94		0.82	
$N_{Individuals}$	196		262		196		262	
Observations	392		524		392		524	
Marginal R^2 / Conditional R^2	0.065 / 0.942		0.215 / 0.862		0.061 / 0.944		0.215 / 0.859	

*Note. 2 CI = Confidence Interval, * p<0.05, ** p<0.01, *** p<0.001.*

5 DISCUSSION

Our models inquire into the effects of changing commuting and telecommuting patterns on workers' BMI during the COVID-19 pandemic. While previous studies conducted during the COVID-19 pandemic have concluded that telecommuting may result in workers incurring in worse dietary habits (*50*) and reduced physical activity (*51*), our results show that the increase in telecommuting has not resulted in a statistically significant increase in workers' BMI. On the contrary, our findings suggest that the increase in telecommuting during the pandemic has resulted in a decrease in BMI for women who were previously commuting by car. When looking at telecommuting replacing active or public transit commutes, telecommuting did not affect women's or men's BMI. Thus, our results emphasise the relevance of encouraging telecommuting (*3*), public transport (*32; 59*), or active travel (*25-27; 29*) use over car commutes for public health reasons as previous works have (*4*). These findings are relevant for policy recommendations since flexibility in telecommuting could be introduced for the benefit of the public health. This can be implemented by providing information to telecommuters about safe and healthy workplace practices, outlining telecommuting practices for companies and their benefits, and the implementation of formal policies on telecommuting guidelines.

The gendered findings between local accessibility as measured by WalkScore and BMI are coherent with previous research (*7*). The built environment has been shown to have differential impacts between women and men, with urban sprawl and walkability having a statistically significant effect only on men (*7; 60; 61*). The WalkScore measure focuses solely on accessibility to local amenities, and ignores further attributes that contribute to the walkability, such as perception, aesthetics, and safety (*16; 18*). While increasing walkability has been shown to beget positive health outcomes in the population (*17; 27*), our results suggest that if only the local-accessibility component of walkability is addressed, then the outcome may only be positive for men. This is coherent with past research that has highlighted the higher attention given by women to safety considerations and micro-scale features of the built environment (*19; 62*).

Other gendered findings included the fact that women with physical disabilities had higher BMIs. This is relevant as disabilities and obesity can have a compounding effect on health outcomes (*12; 45*). As such This illustrates that integration of universal accessibility measures is key for built-environment policies to effectively address gender inequities in urban environments. Improvements in neighborhood safety, the micro-scale built environment, and universal accessibility could therefore go a long way to sustain better health outcomes in women, especially those with disabilities that impact their travel.

In both of our sets of models, when assuming that all considered independent variables remain constant, only women reveal a statistically significant increase in BMI. Additionally, the marginal R^2 of both models for women is lower than men's. This suggests that our set of considered factors are better predictors for men's BMI, and that there are other factors not considered by our models related to the pandemic period that have only significantly affected women. These factors could potentially include changes in nutrition and lifestyles (*47; 63*), increased care-giving roles (*64*), and increasing work-life conflicts during the pandemic (*46*).

6 CONCLUSION

In this paper, we analyzed the factors affecting BMI of employed women and men during the COVID-19 pandemic, with a focus on changing commuting and telecommuting patterns, as well as on local accessibility levels around the household. By utilizing a set of two weighted multi-level linear regressions, we analyzed a survey administered in two waves, in the years 2019 and 2021, within the Montreal CMA. Through a first set of models, we conclude that telecommuting results in decreased BMI for women, and in no statistically significant effect for men. Through our second set of models we inquire into the effect of telecommuting depending on the commuting mode that it is replacing, finding that women's BMI only decreases when telecommuting replaces commutes previously done by car. Reducing motor vehicle usage has been linked to reductions in BMI, but in relation to changing to active travel or public transit (*4; 50*). Our study asserts that, for women, a switch from motor vehicle transport to telecommuting also results in reductions, pontentially due to decreased sedentary time during commutes (*4; 36*). This finding is important as it reveals that telecommuting is benefital to women's heath, instead of mixed (*3*) or adverse (*50*) effects of teleworking presented in previous research.

In terms of the built environment, our study shows that the local accessibility of residential neighborhoods has an effect of decreasing BMI only on men. This relationship, which has been shown previously in the literature (*7; 60*), relates to the increased potential to complete trips by active modes to access amentities, therefore increasing physical activity and decreasing one's BMI (*5; 6; 20; 25; 26; 29; 65*). However, the reason for the same effect not to be present on women potentially relates to local accessibility not being the main relevant factor that increases their walkability levels. In this sense, for women, micro-scale infrastructure characteristics and subjective perceptions on the built environment may be more relevant for influencing physical activity and BMI (*19; 62*).

We acknowledge limitations within our research. Potentially relevant health factors that were not included in our survey include smoking habits, eating habits, and sedantary time. These health components have shown influences on both BMI and overall health (*50*), and should be considered in future research on the impacts of telecommuting and local accessibility on BMI. Furthermore, while BMI has been used as a measure of physical health in this study, we acknowledge its limitations as presented in previous research (*10; 11; 13-15*). Height, fat distribution, and muscle are not considered in using BMI as a diagnostic tool (*15*). This is shown in our models, as vigorous physical activity for women was not necessarily associtated with a lower BMI, but is a core proponent of one's health. Yet, BMI is predictive of body fat content, adverse health outcomes, and general health (*11*). BMI allows us to understand the physical health effects of several factors on the respondents, but further research could include additional components of physical health, such as mental, emotional, and social.

By providing a better understanding of the impacts of telecommuting and local accessibility on workers' health using a longitudenal data analysis approach, we hope to inform public policymaking that effectively address current health issues of the population. More specifically, our results show that, if high levels of telecommuting are meant to be sustained in the future, their health consequences are strongly dependent on workers' gender and commute transport mode being replaced. Additionally, our results illustrate the relevance of improving walkability around homes to promote active mobility, especially for men. However, we have also shown that only focusing on the local-accessibility component of walkability could lead to increasing the gap in active mobility between women and men.

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8 AUTHORS CONTRIBUTION

The authors confirm contribution to the paper as follows: Study conception and design: Commers, Victoriano-Habit, Rodrigue, El-Geneidy; Data collection: Victoriano-Habit, Rodrigue, Kestens, El-Geneidy; Analysis and interpretation of results: Commers, Victoriano-Habit, Rodrigue, Kestens, El-Geneidy; Draft manuscript preparation, Commers, Victoriano-Habit, Rodrigue, Kestens, El-Geneidy. All authors reviewed the results and approved the final version of the manuscript.

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