

Association between Physical Activity and Body Weight: Health Creation and Disease Prevention

Meshefedjian GA^{*1}, Frigault LR², Ibrahima M² and Simard B²

¹Direction régionale de santé publique, Centre Intégré Universitaire de Santé et de Services Sociaux du Centre-Sud-de-l'Île-de-Montréal, Canada

²Service des Connaissances, Centre Intégré Universitaire de Santé et de Services Sociaux du Centre-Sud-de-l'Île-de-Montréal, Canada

*Corresponding author: Meshefedjian GA, Direction régional de santé publique, 1301 rue Sherbrooke Est, Montréal, (Québec) H2L 1M3, Canada, Fax: 514-528-2463, Tel: 514-528-2400, E-mail: garbis.meshefedjian.ccsmtl@sss.gouv.qc.ca

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Abstract

Leisure time physical activity has a broad spectrum of health benefits. The objective of this study was to provide evidence and to support the association between physical activity and body weight. We used data from a probability sample of 8,128 individuals residing in Montreal (Canada). Multinomial multivariate logistic regression was used to determine the association between physical activity and body weight. Results showed no statistical association between physical activity and underweight. However, physical activity was associated with overweight, namely individuals doing less physical activity were significantly more likely to be overweight (OR=1.42; 95%CI=1.18-1.69) than those performing intense physical activity. Additionally, the association between physical activity and obesity showed a negative incremental relationship, i.e. individuals reporting moderate physical activity were 29% more likely to be obese (OR=1.29; 95%CI=1.07-1.55), and those reporting low physical activity were 123% more likely to be obese (OR=2.23; 95%CI=1.80-2.76) compared to intense physical activity status. Leisure time physical activity and overweight/obesity were significantly associated after accounting for several socioeconomic, lifestyle and health-related correlates. Due to the broader positive impact of physical activity on the health status of the individual, we advise health authorities to facilitate the propagation of healthy lifestyle in the community by adopting a health-creation policy in addition to the conventional disease-prevention strategy.

Keywords: Overweight; Obesity; Physical Activity; Cross Sectional Study; Logistic Regression

Introduction

Body-weight, defined by body mass index (BMI), is an important health indicator. Measurements outside normal body-weight range are associated with ill-health outcomes. For instance, mental health and psychological well-being are correlated with underweight, while overweight and obesity are associated with diabetes, cardiovascular disease, kidney diseases and cancer [1-3]. According to the Canadian Community Health Survey, 63.9% (57.9% females and 69.9% males) of Canadian population, ages 18 years and older, are either underweight or overweight/obese [4]. Population based microsimulation models predict that 66% of the adult population in Canada will either be overweight or obese by year 2030 [5]. According to the 2012 edition of Montreal's Local Health Survey Program (TOPO), 52.6% of Montreal adult population are either below or above normal body-weight range. This prevalence seems to be the second highest reported behavioral health problem in Montreal (Appendix).

Although interpersonal variability of body weight may have a genetic component, nonetheless, there are several other factors that may influence the actual body-weight of an individual [6-8]. Some of these factors are readily modifiable (e.g. education, income, physical activity, healthy eating, smoking, stress management, medical care) and some are not (e.g. sex, age, ethnicity, immigration status, chronic health conditions).

Amongst several factors associated with body weight, leisure time physical activity seems to be an effective, non-invasive, inexpensive and affordable means to manage body weight. Several studies have shown a strong correlation between obesity and physical inactivity [9-14]. However, to our knowledge, no previous study has reported the simultaneous association of gender-specific body weight and physical activity in Montreal population. The objective of this study is to show the independent association between physical activity and body weight, controlling for several socioeconomic, lifestyle and health-related variables.

Materials and Methods

Subjects

This study included 8,128 subjects (3,751 men and 4,377 non-pregnant women) between ages 18 and 65 years and living in private households in the city of Montreal, Canada. Sample selection was realized by multistage stratified random probability sampling. Data of this study were extracted from the 2012 edition of Montreal's Local Health Survey Program (TOPO). TOPO data included information on chronic diseases and their major determinants such as: social conditions (employment, education, immigration, material deprivation), lifestyle (smoking, physical activity, fruit and vegetable intake), and use of health care services. The study was approved by the Quebec Provincial Public Health Ethics Committee. Data were collected between February and November 2012 under the supervision of Le Secteur Surveillance de l'État de Santé à Montréal (Health Surveillance in Montreal, Canada). The response rate (41.4%) was computed by using the standard definition of the American Association for Public Opinion Research [15,16]. Detailed information on the survey process is available elsewhere [17,18].

Variables

The main dependent variable was the body-weight. Measurements of body-weight were based on the body mass index (BMI). BMI was computed as the ratio of body-weight (in kilograms) to body-height (in meters square). Both weight and height were self-reported. In this study, the adult body-weight was categorised into four groups according to the Canadian guidelines for body weight classification: underweight ($BMI < 18.5 \text{ kg/m}^2$), normal weight ($18.5 \text{ kg/m}^2 \leq BMI < 25.0 \text{ kg/m}^2$), overweight ($25 \text{ kg/m}^2 \leq BMI < 30 \text{ kg/m}^2$), and obese ($BMI \geq 30 \text{ kg/m}^2$) [19].

The main independent variable was the leisure time physical activity. The latter was measured by the short version of the International Physical Activity Questionnaire (IPAQ) [20]. Leisure time physical activity data referred to the time spent being physically active during the past 7 days. Responses were grouped into low, moderate and high categories based on the Metabolic Equivalent Task minutes per week (MET-min/wk) [20]. All other socioeconomic, lifestyle and health-related variables were used to account for their independent effect on the physical activity. These variables were: sex, age, education (less than secondary/secondary/university), language spoken at home (French only/English only/other), residency status (immigrant/non-immigrant), household income (\$20,000 intervals), material deprivation index (a measure of socioeconomic conditions at the neighborhood level grouped into quintiles), smoking status (current smoker/past smoker/non-smoker), daily intake of fruits and vegetables (less than five servings/five servings and more), alcohol consumption (non-excessive/excessive, i.e. five or more drinks (six for men) on the same occasion at least 12 times in the last year), stress in life (yes/no), having a family physician (yes/no), and presence of physical or mental problems (the respondent's self-rated overall health as well as illnesses diagnosed by a health professional) [21]. Diagnosed physical illnesses were asthma, fibromyalgia, arthritis, back pain, high blood pressure, chronic bronchitis, emphysema or chronic obstructive pulmonary disease, diabetes, heart disease or cardiac problems, and cancer. Diagnosed mental health illnesses were mood disorder (depression, bipolar disorder, or dysthymia) and anxiety disorder (phobia, obsessive-compulsive disorder, or panic disorder).

Statistical analysis

The initial analyses were stratified by sex. However, since results did not differ by sex except for annual household income variable, we created a sex-by-household income interaction variable and combined men and women data to gain power. First, we tabulated the frequency distribution of socioeconomic, lifestyle and health-related characteristics of the study population. Second, we used the Rao-Scott χ^2 test to analyze bivariate associations between explanatory and outcome variables; significance was set at $P < 0.05$. For the multivariable analysis, we used multinomial logistic regression because our outcome variable had four nominal values. We compared each of the underweight, overweight and obese categories to the normal-weight group. Accordingly, we reported adjusted odds ratio (OR) estimates and their 95% confidence intervals (CIs); significance was affirmed if the 95% CI of an OR estimate did not include unity. All analyses were performed using SAS, version 9.1.3 (SAS Institute, Inc.).

Results

Table 1 show that our sample has a rather homogeneous sex and age distribution. On the other hand, more than half of the sample report speaking only French at home and having university education. Additionally, more than 60% are born in Canada and have annual household income equal to or higher than CAN\$40,000. Table 1 also provides the prevalence of some lifestyle habits in the population such as low physical activity (21%); currently smoking (22%); insufficient intake of fruits and vegetables (60%); and excessive use of alcohol (17%), as well as some health related variables such as overweight/obesity (48%), high stress in life (33%), physical and mental health problems (58% and 86% respectively) and access to family physician (59%). All these study variables are significantly associated with body weight except for language spoken at home and stress in life (Table 2).

In the multivariate analysis, physical activity was not statistically associated with underweight (Table 3, Column A). Nonetheless, older age (OR=0.72; 95%CI=0.62-0.83), having a family physician (OR=0.69; 95%CI=0.48-0.98), and males with high annual household income (OR=0.23; 95%CI=0.10-0.55) respectively showed a protective effect, while suffering from physical health problems was a risk factor (OR=1.48; 95%CI=1.04-2.12).

Characteristics		
Unweighted	Number of Observations	Proportion (percent)
Sex:		
- Male	3751	46.2
- Female	4377	53.8
Age (year):		
- 18 to 24	968	11.9
- 25 to 34	1844	22.7
- 35 to 44	1843	22.7
- 45 to 54	1810	22.3
- 55 to 64	1663	20.5
Language spoken at home:		
- French only	4508	55.5
- English only	1645	20.2
- Other (several)	1975	24.3
Education:		
- Less than secondary	749	9.5
- Secondary to less than university	3067	38.7
- University studies and more	4112	51.9
Residency status:		
- Canadian (born in Canada)	5120	63.4
- Landed immigrant (10 years or more)	1495	18.5
- Landed immigrant (less than 10 years)	1467	18.2
Annual household income (CAN\$):		
- Less than \$20,000	1265	15.6
- \$20,000 to \$39,999	1739	21.4
- \$40,000 to \$59,999	1464	18.0
- \$60,000 to \$79,999	1043	12.8
- \$80,000 and more	2617	32.2
Material deprivation index ⁽¹⁾:		
- Most privileged (quintile 1)	1569	20.2
- Privileged (quintile 2)	1626	20.9
- Average (quintile 3)	1577	20.3
- Deprived (quintile 4)	1593	20.5
- Most deprived (quintile 5)	1412	18.2
Weighted	% (95%CI) [†]	
Physical activity status (past seven days):		
- Low	20.8 (19.8-21.7)	
- Moderate	39.8 (38.7-40.9)	
- Intense	39.5 (38.4-40.6)	
Smoking status:		
- Currently smoking	22.0 (21.0-22.9)	
- Ex-smokers	18.8 (18.0-19.7)	
- Currently not smoking	59.2 (58.1-60.3)	
Daily intake of fruits and vegetables:		
- Less than five servings	60.0 (58.9-61.1)	
- Five servings and more	40.0 (38.9-41.1)	
Alcohol consumption:		
- Non-excessive	82.8 (81.9-83.6)	
- Excessive ⁽²⁾	17.2 (16.4-18.1)	
Body weight:		
- Underweight (BMI<18.5)	2.9 (2.6-3.3)	
- Average weight (18.5≤BMI<25.0)	49.2 (48.0-50.3)	
- Overweight (25.0≤BMI<30.0)	32.9 (31.8-34.0)	
- Obese (BMI≥30.0)	15.0 (14.2-15.8)	
Daily perceived stress in life:		
- Low	25.0 (24.0-26.0)	
- Moderate	42.5 (41.4-43.6)	
- High	32.5 (31.5-33.6)	
Presence of physical health problem:		
- Yes (perceived and/or diagnosed ³)	58.4 (57.2-59.5)	
- No (neither perceived nor diagnosed)	41.6 (40.5-42.8)	

Weighted	% (95%CI) [†]
Presence of mental health problem:	
- Yes (perceived and/or diagnosed [‡])	86.1 (85.3-86.9)
- No (neither perceived nor diagnosed)	13.9 (13.1-14.7)
Have a family physician:	
- Yes	58.9 (57.8-60.0)
- No	41.1 (40.0-42.2)

Table 1: Socioeconomic, lifestyle and health-related variables of the study population (n=8,128). Montreal, 2012

[†]% =Percent prevalence; (95%CI)= 95% confidence interval

[‡]A measure of socioeconomic conditions at the neighborhood level grouped into quintiles

[§]Five or more drinks (six for men) on the same occasion at least 12 times in the last year

^{||}Asthma, fibromyalgia, arthritis, back pain, high blood pressure, chronic bronchitis, emphysema or chronic obstructive pulmonary disease, diabetes, heart-disease or cardiac problem, and cancer

[¶]Mood disorder (depression, bipolar disorder, mania, or dysthymia including manic depression) and anxiety (phobia, obsessive-compulsive disorder or panic disorder)

Characteristics	Underweight (BMI<18.5)	Normal weight (18.5≤BMI<25)	Overweight (25≤BMI<30)	Obese (BMI≥30)	p-value ^{††}
	% (95%CI) [†]	% (95%CI) [†]	% (95%CI) [†]	% (95%CI) [†]	
Total	3.1 (2.8-3.5)	47.4 (46.4-48.4)	33.8 (32.8-34.8)	15.7 (14.9-16.4)	
Sex:					<0.001
- Male	1.6 (1.2-2.1)	42.2 (40.5-43.8)	41.6 (40.0-43.3)	14.6 (13.4-15.8)	
- Female	4.3 (3.7-5.0)	56.6 (55.1-58.1)	23.7 (22.3-25.0)	15.4 (14.3-16.6)	
Age (year):					<0.001
- 18 to 24	7.3 (5.5-9.1)	63.2 (59.9-66.5)	21.3 (18.5-24.1)	8.3 (6.4-10.1)	
- 25 to 34	3.7 (2.8-4.6)	56.8 (54.3-59.2)	28.2 (25.9-30.4)	11.4 (9.8-13.0)	
- 35 to 44	2.3* (1.6-3.0)	47.8 (45.4-50.1)	35.6 (33.3-37.9)	14.4 (12.7-16.1)	
- 45 to 54	1.7* (1.1-2.4)	43.0 (40.6-45.4)	36.3 (34.1-38.6)	19.0 (17.1-20.8)	
- 55 to 64	1.6* (1.0-2.2)	39.6 (37.2-42.0)	39.0 (36.5-41.0)	19.9 (17.9-21.8)	
Language spoken at home:					0.189
- French	2.8 (2.3-3.3)	50.3 (48.8-51.8)	31.8 (30.4-33.2)	15.1 (14.0-16.2)	
- English	2.5* (1.7-3.4)	48.5 (45.9-51.1)	33.9 (31.4-36.4)	15.1 (13.3-17.0)	
- Other	3.6 (2.7-4.5)	47.4 (45.0-49.8)	34.4 (32.1-36.7)	14.6 (12.9-16.3)	
Education:					<0.001
-Less than secondary	2.5* (1.3-3.7)	2.5* (1.3-3.7)	37.1 (33.3-40.9)	25.8 (22.3-29.2)	
-Secondary to less than university	3.1 (2.5-3.8)	3.1 (2.5-3.8)	34.1 (32.3-35.9)	16.9 (15.5-18.3)	
-University studies and more	2.8 (2.3-3.3)	2.8 (2.3-3.3)	31.3 (29.9-32.8)	11.8 (10.8-12.9)	
Residency status:					<0.001
- Canadian (born in Canada)	3.0 (2.5-3.4)	49.3 (47.9-50.8)	31.8 (30.5-33.2)	15.9 (14.8-16.9)	
- Landed immigrant (10 years or more)	3.0* (2.1-3.9)	45.2 (42.4-47.9)	35.6 (32.9-38.2)	16.3 (14.3-18.3)	
- Landed immigrant (less than 10 years)	2.9* (2.0-3.8)	52.8 (50.0-55.5)	33.8 (31.2-36.5)	10.6 (8.9-12.3)	
Household income (CAN\$):					<0.001
- Less than \$20,000	4.1* (2.9-5.4)	48.8 (45.8-51.7)	30.0 (27.3-32.8)	17.1 (14.9-19.3)	
- \$20,000 to \$39,999	3.3 (2.4-4.2)	49.0 (46.5-51.6)	32.4 (30.0-34.8)	15.3 (13.5-17.1)	
- \$40,000 to \$59,999	2.5* (1.6-3.4)	48.6 (45.8-51.3)	33.0 (30.4-35.6)	15.9 (14.0-17.8)	
- \$60,000 to \$79,999	2.6* (1.6-3.6)	47.7 (44.5-51.0)	32.1 (29.1-35.1)	17.6 (15.1-20.1)	
- \$80,000 and more	2.5 (1.9-3.2)	50.3 (48.3-52.3)	34.8 (32.8-36.7)	12.4 (11.1-13.7)	
Material deprivation index⁽¹⁾:					<0.001
- Most privileged (quintile 1)	3.4 (2.5-4.4)	56.0 (53.4-58.6)	29.7 (27.3-32.2)	10.9 (9.3-12.5)	
- Privileged (quintile 2)	2.2* (1.5-3.0)	49.2 (46.6-51.8)	33.8 (31.3-36.2)	14.8 (13.0-16.7)	
- Average (quintile 3)	2.7* (1.8-3.5)	47.9 (45.3-50.6)	33.2 (30.7-35.7)	16.2 (14.2-18.1)	
- Deprived (quintile 4)	2.9* (2.0-3.8)	46.5 (43.9-49.1)	34.1 (31.6-36.7)	16.5 (14.6-18.4)	
- Most deprived (quintile 5)	3.5* (2.5-4.6)	43.9 (41.1-46.7)	34.3 (31.7-37.0)	18.3 (16.1-20.4)	
Physical activity status (past seven days):					<0.001
- Low	3.0 (2.1-3.8)	40.5 (38.0-43.0)	34.5 (32.1-37.0)	22.0 (19.9-24.1)	
- Moderate	3.1 (2.4-3.7)	50.5 (48.7-52.3)	32.5 (30.8-34.2)	14.0 (12.8-15.3)	
- Intense	2.9 (2.2-3.5)	52.3 (50.4-54.2)	32.6 (30.9-34.4)	12.2 (11.0-13.4)	
Smoking status:					<0.001
- Current smoker	2.8 (2.0-3.6)	51.2 (48.7-53.6)	32.7 (30.4-35.0)	13.4 (11.7-15.1)	
- Past smoker	1.9* (1.2-2.6)	42.3 (39.7-44.8)	37.3 (34.8-39.8)	18.6 (16.5-20.6)	
- Non-smoker	3.4 (2.8-3.9)	50.7 (49.2-52.2)	31.6 (30.1-33.0)	14.4 (13.4-15.5)	
Daily consumption of fruits and vegetables:					<0.001
- Less than five servings	3.1 (2.5-3.6)	47.1 (45.6-48.6)	34.2 (32.7-35.6)	15.7 (14.6-16.8)	
- Five servings and more	2.9 (2.3-3.5)	52.1 (50.3-53.9)	31.1 (29.4-32.8)	14.0 (12.7-15.2)	

Characteristics	Underweight (BMI<18.5)	Normal weight (18.5≤BMI<25)	Overweight (25≤BMI<30)	Obese (BMI≥30)	p-value ^{††}
	% (95%CI) [†]	% (95%CI) [†]	% (95%CI) [†]	% (95%CI) [†]	
Alcohol consumption: - Non-excessive - Excessive ⁽²⁾	2.9 (2.4-3.3) 3.0* (2.0-3.9)	48.3 (47.0-49.5) 53.2 (50.5-56.0)	33.0 (31.8-34.2) 33.1 (30.5-35.8)	15.9 (14.9-16.8) 10.7 (8.9-12.4)	<0.001
Daily perceived stress in life: - Low - Moderate - High	3.0 (2.2-3.8) 3.0 (2.3-3.6) 2.9 (2.3-3.6)	47.8 (45.5-50.2) 50.9 (49.2-52.7) 47.8 (45.8-49.8)	33.4 (31.2-35.6) 32.4 (30.7-34.1) 33.3 (31.4-35.2)	15.9 (14.2-17.6) 13.7 (12.5-14.9) 16.0 (14.5-17.4)	0.147
Presence of physical health problem: - Yes (perceived and/or diagnosed ³) - No (neither perceived nor diagnosed)	2.9 (2.2-3.5) 2.8 (2.3-3.4)	42.4 (40.6-44.2) 54.9 (53.3-56.5)	33.9 (32.1-35.7) 31.8 (30.4-33.3)	20.8 (19.3-22.3) 10.5 (9.5-11.4)	<0.001
Presence of mental health problem: - Yes (perceived and/or diagnosed ⁴) - No (neither perceived nor diagnosed)	4.1* (2.8-5.4) 2.7 (2.3-3.1)	45.8 (42.6-48.9) 49.5 (48.3-50.8)	45.8 (42.6-48.9) 49.5 (48.3-50.8)	19.3 (16.8-21.7) 14.4 (13.5-15.3)	<0.001
Have a family physician: - Yes - No	2.5 (2.0-2.9) 3.5 (2.9-4.2)	47.1 (45.6-48.5) 51.9 (50.1-53.8)	33.5 (32.1-34.9) 32.2 (30.5-33.9)	17.0 (15.9-18.1) 12.3 (11.1-13.5)	<0.001

Table 2: Association between body weight and socioeconomic, lifestyle and health-related variables (n=8,128). Montreal, 2012

[†]Proportion and 95% confidence interval

^{††}Chi-Square Rao-Scott test

*Estimate is fairly accurate, coefficient of variation (CV), 15% <CV≤25%, should be interpreted with caution

¹A measure of socioeconomic conditions at the neighborhood level grouped into quintiles

²Five or more drinks (six for men) on the same occasion at least 12 times in the last year

³Asthma, fibromyalgia, arthritis, back pain, high blood pressure, chronic bronchitis, emphysema or chronic obstructive pulmonary disease, diabetes, heart-disease or cardiac problem, and cancer

⁴Mood disorder (depression, bipolar disorder, mania, or dysthymia including manic depression) and anxiety (phobia, obsessive-compulsive disorder or panic disorder)

Characteristics	A	B	C
	Underweight (BMI<18.5) vs Normal (18.5≤BMI<25)	Overweight (25≤BMI<30) vs Normal (18.5≤BMI<25)	Obese (BMI≥30) vs Normal (18.5≤BMI<25)
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Physical activity status (past seven days): - Low - Moderate - Intense	1.40 (0.88-2.23) 1.09 (0.76-1.57) Reference	1.42 (1.18-1.69) 1.15 (1.00-1.32) Reference	2.23 (1.80-2.76) 1.29 (1.07-1.55) Reference
Age (year): - Increment of 10	0.72 (0.62-0.83)	1.29 (1.23-1.36)	1.23 (1.15-1.32)
Language spoken at home: - French - English - Other	0.82 (0.54-1.27) 0.81 (0.47-1.39) Reference	0.93 (0.78-1.10) 1.08 (0.87-1.33) Reference	0.86 (0.69-1.08) 0.88 (0.67-1.15) Reference
Education: - Less than secondary - Secondary to less than university - University studies and more	1.41 (0.74-2.66) 1.10 (0.78-1.56) Reference	1.77 (1.38-2.27) 1.34 (1.17-1.54) Reference	2.39 (1.77-3.22) 1.61 (1.34-1.93) Reference
Residency status: - Non-immigrant (Born in Canada/ Landed ≥ 10 years) - Immigrant (Landed < 10 years)	Reference 0.65 (0.40-1.06)	Reference 1.17 (0.97-1.42)	Reference 0.64 (0.48-0.84)
Material deprivation index⁽¹⁾: - Privileged to deprived (quintile)	0.97 (0.86-1.10)	1.10 (1.04-1.15)	1.16 (1.09-1.23)
Smoking status: - Current smoker - Past smoker - Non-smoker	0.76 (0.49-1.16) 0.91 (0.55-1.52) Reference	0.88 (0.75-1.04) 1.10 (0.94-1.30) Reference	0.72 (0.57-0.90) 1.30 (1.06-1.59) Reference
Daily consumption of fruits and vegetables: - Less than five times - Five times and more	1.20 (0.85-1.69) Reference	1.06 (0.93-1.20) Reference	1.12 (0.95-1.31) Reference

Characteristics	A	B	C
	Underweight (BMI<18.5) vs Normal (18.5≤BMI<25)	Overweight (25≤BMI<30) vs Normal (18.5≤BMI<25)	Obese (BMI≥30) vs Normal (18.5≤BMI<25)
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Alcohol consumption: - Non-excessive - Excessive ⁽²⁾	1.04 (0.66-1.65) Reference	1.04 (0.87-1.23) Reference	1.38 (1.07-1.77) Reference
Stress in life: - No (low/moderate) - Yes (high)	Reference 1.05 (0.73-1.49)	Reference 1.15 (1.00-1.31)	Reference 1.18 (1.00-1.40)
Presence of physical health problem: - Yes (perceived and/or diagnosed ³) - No (neither perceived nor diagnosed)	1.48 (1.04-2.12) Reference	1.21 (1.06-1.38) Reference	2.04 (1.73-2.42) Reference
Presence of mental health problem: - Yes (perceived and/or diagnosed ⁴) - No (neither perceived nor diagnosed)	1.21 (0.75-1.94) Reference	1.01 (0.83-1.22) Reference	1.18 (0.94-1.49) Reference
Have a family physician: - Yes - No	0.69 (0.48-0.98) Reference	1.09 (0.95-1.25) Reference	1.11 (0.93-1.33) Reference
INTERACTION[†]			
Female and Household income: - Low (less than \$60,000) - High (\$60,000 and more)	Reference 1.78 (0.87-3.64)	Reference 0.78 (0.57-1.06)	Reference 1.02 (0.68-1.52)
Male and Household income: - Low (less than \$60,000) - High (\$60,000 and more)	Reference 0.23 (0.10-0.55)	Reference 1.60 (1.25-2.05)	Reference 1.56 (1.13-2.15)

Table 3: Multivariate association between body weight and socioeconomic, lifestyle and health-related variables (n=8,128). Montreal, 2012

*Estimate is fairly accurate, coefficient of variation (CV), 15% <CV≤25%, should be interpreted with caution

[†]The separate sex and household income variables are not shown in this table, however, they are included in the model

¹A measure of socioeconomic conditions at the neighborhood level grouped into quintiles

²Five or more drinks (six for men) on the same occasion at least 12 times in the last year

³Asthma, fibromyalgia, arthritis, back pain, high blood pressure, chronic bronchitis, emphysema or chronic obstructive pulmonary disease, diabetes, heart-disease or cardiac problem, and cancer

⁴Mood disorder (depression, bipolar disorder, mania, or dysthymia including manic depression) and anxiety (phobia, obsessive-compulsive disorder or panic disorder)

Physical activity was statistically associated with overweight (Table 3, Column B). Namely, those with low physical activity were significantly more likely to be overweight (OR=1.42; 95%CI=1.18-1.69) than those with intense physical activity. This association was adjusted for all other variables including daily fruit and vegetable intake. Furthermore, males with high annual household income were significantly more likely to be overweight than their low-income counterparts (OR=1.60; 95%CI=1.25-2.05). However, there was no significant association between body-weight and household income for female population.

The association between physical activity and obesity (Table 3, Column C) was rather interesting because it showed a negative incremental relationship, i.e. the lower the physical activity, the higher the odd of being obese. Hence, individuals reporting moderate physical activity were 29% more likely to be obese (OR=1.29; 95%CI=1.07-1.55), while those reporting low physical activity were 123% more likely to be obese (OR=2.23; 95%CI=1.80-2.76) compared to their intense physical activity counterparts and controlling for all other relevant variables in the model. The association of some correlates were similar in both overweight and obese models, such as, age, education, material deprivation index, present of physical health problem and sex-specific annual household income. However, other correlates were model specific, for instance, recent immigrants were 36% less likely to be obese (OR=0.64; 95%CI=0.48-0.84) and non-excessive alcohol consumers were 38% more likely to be obese. It is worthy of note the association of smoking status with obesity, namely, current smokers were 28% less likely to be obese (OR=0.72; 95%CI=0.57-0.90), while past smokers were 30% more likely to be obese (OR=1.30; 95%CI=1.06-1.59) compared to non-smokers.

Discussion

We studied the independent association between physical activity and body weight among the adult Canadian population in Montreal city. Results of our multivariable regression analysis, concurrently comparing underweight, overweight and obese groups with normal-weight adults, revealed that physical activity is significantly associated with overweight and obesity after controlling for relevant socioeconomic, lifestyle and health-related variables. Moreover, this association revealed a “dose-response” relationship; namely, the odds of being overweight or obese were significantly increased with reduced leisure time physical activity. Our findings confirm similar associations between body weight and physical activity reported in the literature [11,12,22,23].

Being overweight or obesity is an important risk for many chronic diseases and premature death [3,24]. This study provided evidence that leisure time physical activity is a significant protective factor to reduce body weight independent of the recommended intake of fruits and vegetables. Interestingly, leisure time physical activity is an inexpensive, non-invasive, effective and easy to implement method to manage body weight with no known side effects. Moreover, the benefits of physical activity are observed over a large spectrum of diseases and disability, as well as within different groups of the population such as the elderly, the adolescents, adults, and pregnant women [3,25-36]. In fact, beyond its impact on body weight, physical activity has also been reported to improve physical appearance and enhances mood and self-esteem [37]. In terms of prevention, Lee *et al.* (2017) suggest that increasing physical activity could yield billions of dollars in saving that outweigh the cost of intervention [38]. Given the large spectrum of its benefits and the ease of its implementation, shouldn't daily practice of physical activity constitute a vital recommendation of every health professional? For example, Institute of Medicine suggests a 60min/day of moderate-intensity activity to prevent overweight or obesity [39]. Our study supports the latter argument and advocates the propagation of leisure time physical activity as an effective means towards health creation in addition to disease prevention.

The predominant health problems of the adult population in Montreal are related to behavioral and lifestyle habits (Appendix). In another words, most prevalent diseases are preventable in this population. Hence, wouldn't it be more effective if public health departments explore and encourage health creation, in addition to disease prevention, to attain an optimum population health status? We think providing the population with better opportunities for leisure time physical activity is an excellent avenue towards an ultimate attainment of healthy body, mind and spirit. Indeed, some studies confirm the positive impact of the neighborhood walkability/design-for-biking interventions on the reduction of overweight and obesity [40,41]. Hence, we urge local governments to design neighborhoods that facilitate the propagation of healthy lifestyle in the community.

Conclusion`

Our research showed an independent and statistically significant negative association between the practice of leisure time physical activity and overweight/obesity after accounting for several other socioeconomic, lifestyle and health-related correlates. Furthermore, due to the broader positive impact of physical activity on the health status of the individual, this study urged health authorities to facilitate the propagation of healthy lifestyle in the community by adopting a health-creation policy besides the conventional disease-prevention strategy.

Limitations

This study has some limitations inherent to its design. As a population survey, the data were based on self-reported information which may introduce misclassification bias should the information be wrongly reported. For instance, it is suggested that the self-reported measurement of body-weight be regarded as underestimate [42]. Moreover, the low response rate could lead to selection bias should a particular characteristic of the sample be misrepresented. However, neither of these limitations presented a threat to the quality of our data, because distributions of several sociodemographic variables were comparable to those of the census data. Additionally, the cross-sectional nature of the study design does not let us infer any causal relationship between body-weight and physical activity variables. Finally, this study did not consider genetic and sedentary lifestyle determinants of body-weight because data were not available.

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Appendix

References

1. Molarius A, Berglund K, Eriksson C, Erikson HG, Bostrom ML, et al. (2009) Mental health symptoms in relation to socio-economic conditions and lifestyle factors-a population-based study in Sweden. *BMC Public Health* 9: 302.
2. Ali SM, Lindstrom M (2006) Socioeconomic, psychosocial, behavioural, and psychological determinants of BMI among young women: differing patterns for underweight and overweight/obesity. *Eur J Public Health* 16: 325-31.
3. GBD 2015 Obesity Collaborators (2017) Health effects of overweight and obesity in 195 countries over 25 years. *N Engl J Med* 377: 13-27.
4. Statistics Canada. Measured adult body mass index (BMI) (World health Organization classification) by age group and sex, Canada and provinces, Canadian community health survey- Nutrition, Canada.
5. Hennessy D, Garner R, Flanagan WM, Wall R, Nadeau C (2017) Development of a population-based microsimulation model of body mass index. *Health Rep* 28: 20-30.
6. Celis-Morales CA, Lyall DM, Gray S, Steell L, Anderson J, et al. (2017) Dietary fat and total energy intake modifies the effect of genetic profile risk score on obesity: evidence from 48,170 UK Biobank participants. *Int J Obes (Lond)* 41: 1761-8.
7. Gabrielli AP, Manzardo AM, Butler MG (2017) Exploring genetic susceptibility to obesity through genome functional pathway analysis. *Obesity* 25: 1136-43.

8. Sardahaee FS, Holmen TL, Micali N, Kvaloy K (2017) Effects of single genetic variants and polygenic obesity risk scores on disordered eating in adolescents-The HUNT study. *Appetite* 118: 8-16.
9. Hruby A, Manson JE, Qi L, Rim EB, Sun Q, et al. (2016) Determinants and consequences of obesity. *Am J Public Health* 106: 1656-62.
10. Van Dyck D, Cerin E, De Bourdeaudhuij I, Hinckson E, Ries RS, et al. (2015) International study of objectively measured physical activity and sedentary time with body mass index and obesity: IPEN adult study. *Int J Obes (Lond)* 39: 199-207.
11. Park J, Ishikawa-Takata K, Tanaka S, Hikiyama Y, Ohkawara K, et al. (2014) The relationship of body composition to daily physical activity in free-living Japanese adult men. *Br J Nutr* 111: 182-8.
12. Park J, Ishikawa-Takata K, Tanaka S, Hikiyama Y, Ohkawara K, et al. (2011) Relationship of body composition to daily physical activity in free-living Japanese adult women. *Br J Nutr* 106: 1117-27.
13. Zanovec M, Johnson LG, Marx BD, Keenan MJ, Tuuri G (2009) Self-reported physical activity improves prediction of body fatness in young adults. *Med Sci Sports Exerc* 41: 328-35.
14. Slentz CA, Duscha BD, Johnson JL, Ketchum K, Aiken LB, et al. (2004) Effects of the amount of exercise on body weight, body composition, and measures of central obesity: STRRIDE—a randomized controlled study. *Arch Intern Med* 164: 31-9.
15. The American Association for Public Opinion Research (2011) Standard definition: final dispositions of case codes and outcome rates for survey (7th Edn) AAPOR, USA.
16. Kass GV (1980) An exploratory technique for investigating large quantities of categorical data. *Appl Stat* 29: 119-27.
17. Frigault L-R, Ait Kaci Azzou S, Molloy EJK, Ammarguella F, Couture M, et al. (2013). What works? Getting the general population to go online in mixed mode local health survey 2013, Canada.
18. Meshefedjian GA, Ouimet MJ, Frigault LR, Leane V, Ait Kaci Azzou S, et al. (2012) Association of material deprivation status, access to health care services, and lifestyle with screening and prevention of disease, Montreal, Canada 2012. *Prev Chronic Dis* 13: 137.
19. Health Canada (2018) Canadian Guidelines for Body Weight Classification in Adults, Canada.
20. IPAQ Committee Research (2005) Guidelines for the data processing and analysis for the International Physical Activity Questionnaire, USA.
21. Pampalon R, Hamel D, Gamache P, Raymond G (2009) A deprivation index for health planning in Canada. *Chronic Dis Can* 29: 178-91.
22. Koolhass CM, Dhana K, Schoufour JD, Ikram MA, Kavousi M, et al. (2017) Impact of physical activity on the association of overweight and obesity with cardiovascular disease: the Rotterdam study. *Eur J Prev Cardiol* 24: 934-41.
23. Dankel SJ, Loenneke JP, Loprinzi PD (2017) Health outcomes in relation to physical activity status, overweight/obesity, and history of overweight/obesity: a review of the WATCH program. *Sports Med* 47: 1029-34.
24. Kivimaki M, Kuosma E, Ferrie JE, Luukkonen R, Nyberg ST, et al. (2017) overweight, obesity, and risk of cardiometabolic multimorbidity: pooled analysis of individual-level data for 120813 adults from 16 cohort studies from the USA and Europe. *Lancet Public Health* 2: e277-85.
25. Magro-Malosso ER, Saccone G, Di Tommaso M, Roman A, Berghella V (2017) Exercise during pregnancy and risk of gestational hypertensive disorders: a systematic review and meta-analysis. *Acta Obstet Gynecol Scand* 96: 921-31.
26. Lefèvre-Colau MM, Nguyen C, Haddad R, Delamarche P, Paris G, et al. (2016) Is physical activity, practiced as recommended for health benefit, a risk factor for osteoarthritis? *Ann Phys Rehabil Med* 59: 196-206.
27. White DK, Gabriel KP, Kim Y, Lewis CE, Sternfeld B (2015) Do short spurts of physical activity benefit cardiovascular health? The CARDIA study. *Med Sci Sports Exerc* 47: 2353-8.
28. Strobl R, Muller M, Thorand B, Linkohr B, Autenrieth CS, et al. (2014) Men benefit more from midlife leisure-time physical activity than women regarding the development of late-life disability: results of the KORA-Agee study. *Prev Med* 62: 8-13.
29. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, et al. (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 380: 219-29.
30. Gaesser GA, Angadi SS, Sawyer BJ (2011) Exercise and diet, independent of weight loss, improve cardiometabolic risk profile in overweight and obese individuals. *Phys Sportsmed* 39: 87-97.
31. Lakka TA, Bouchard C (2005) Physical activity, obesity and cardiovascular diseases. *Handb Exp Pharmacol* 170: 137-63.
32. Fletcher GF (1993) The value of exercise in preventing coronary atherosclerotic heart disease. *Heart Dis Stroke* 2: 183-7.
33. Botosaneanu A, Chen H, Ambrosius WT, Allore HG, Anton S, et al. (2017) Effect of metabolic syndrome on the mobility benefit of a structured physical activity intervention: the lifestyle interventions and independence for elders randomized clinical trial. *J Am Geriatr Soc* 65: 1244-50.
34. Al-Khudairy L, Loveman E, Colquitt JL, Mead E, Johnson RE, et al. (2017) Diet, physical activity and behavioural interventions for the treatment of overweight or obese adolescents aged 12 to 17 years. *Cochrane Database Syst Rev* 6: CD012691.
35. Di Mascio D, Magro-Malosso ER, Saccone G, Marhefka GD, Berghella V (2016) Exercise during pregnancy in normal-weight women and risk of preterm birth: a systematic review and meta-analysis of randomized controlled trials. *Am J Obstet Gynecol* 215: 561-71.
36. Lee IM, Djoussé L, Sesso HD, Wang L, Buring JE (2010) Physical activity and weight gain prevention. *JAMA* 303: 1173-9.
37. Penedo FJ, Dahn JR (2005) Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr Opin Psychiatry* 18: 189-93.
38. Lee BY, Adam A, Zenkov E, Hertenstein D, Ferguson MC, et al. (2017) Modeling the economic and health impact of increasing children's physical activity in the United States. *Health Aff* 36: 902-8.
39. Institute of Medicine (2002) Food and Nutrition Board, Institute of Medicine. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids (macronutrients). Washington, DC: National Academics Press, USA.
40. Creatore MI, Glazier RH, Moineddin R, Fazli GH, Johns A, et al. (2016) Association of neighborhood walkability with change in overweight, obesity, and diabetes. *JAMA* 315: 2211-20.
41. Brown BB, Smith KR, Hanson H, Fan JX, Kowaleski-Jones L, et al. (2013) Neighborhood design for walking and biking: physical activity and body mass index. *Am J Prev Med* 44: 231-8.
42. Millar WJ (1986) Distribution of body weight and height; comparison of estimates based on self-reported and observed measures. *J Epidemiol Community Health* 40: 319-23.

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