
The role of physical activity and body mass index in the health care use of adults with asthma

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Background: Health care use in patients with asthma is affected by many factors, including sex and ethnicity. The role of physical activity (PA) and body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) in this relationship is unknown.

Objective: To determine the role of PA and BMI in the health care use of patients with asthma.

Methods: A sample of adults with asthma (n=6,835) and without asthma (n=78,051) from cycle 3.1 of the Canadian Community Health Survey was identified. Health care use was self-reported as overnight hospital stays (yes or no), length of overnight hospital stay (<4 or ≥4 nights), and physician consultations (<3 or ≥3). Self-reported physical activities were used to derive total energy expenditure and to classify participants as active (>3.0 kcal/kg of body weight per day), moderately active (1.5–3.0 kcal/kg of body weight per day), and inactive (<1.5 kcal/kg of body weight per day). The BMI was categorized as normal weight (18.5–24.9), overweight (25.0–29.9), and obese (30.0–59.9).

Results: Adjusted logistic regression models revealed that patients with asthma were more likely to have an overnight hospital stay (odds ratio [OR], 2.25; 95% confidence interval [CI], 1.95–2.60), 4 or more overnight hospital stays (OR, 1.48; 95% CI, 1.12–1.96), and 3 or more physician consultations (OR, 2.43; 95% CI, 2.18–2.71) compared with patients without asthma (OR, 1.00). Inactive patients with asthma were more likely to have an overnight hospital stay (OR, 1.68; 95% CI, 1.31–2.16) and 3 or more physician consultations (OR, 1.23; 95% CI, 1.04–1.46) than active patients with asthma (OR, 1.00). Inactive/obese patients with asthma were 2.35 (95% CI, 1.69–3.27) times more likely to have an overnight hospital stay and 2.76 (95% CI, 2.11–3.60) times more likely to have 3 or more physician consultations than active/normal weight patients with asthma (OR, 1.00).

Conclusions: Higher PA levels are associated with lower health care use in individuals with and without asthma. In those with asthma, PA was a more important factor in overnight hospital stays than BMI, whereas both BMI and PA were important determinants of physician consultations.

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INTRODUCTION

Physical activity (PA) and fitness levels have been shown to be lower in patients with asthma when compared with healthy peers.^{1–3} At the same time, many patients with asthma are overweight or obese.⁴ Obese individuals have more physician visits and are more likely to seek medical care⁷; this increased health care use has proved to be a great burden on the health care system.⁸ Studies examining obesity and health care use have also found that obese individuals are more likely to use prescription asthma medications⁹ and that asthma increases the odds of health care use by 33% in obese individuals.¹⁰ Nevertheless, PA-induced weight loss has been shown to improve asthma symptoms in an obese population.¹¹

Previous literature has established an association between direct and indirect health care costs of patients with asthma such that cost increases with the severity of disease.¹² Other

factors related to increased health care use in patients with asthma include female sex,¹³ lower asthma-specific health-related quality of life,¹⁴ low socioeconomic status,¹⁵ ethnicity,^{15,16} smoking status,¹⁶ and type of insurance coverage.¹⁷ In the general population, higher cardiorespiratory fitness has been associated with lower health care use.¹⁸ Nevertheless, research has yet to examine the relationship between PA levels of asthmatic patients and health care use while accounting for obesity. We, therefore, sought to determine the following: (1) whether the health care use of asthmatic patients and nonasthmatic patients differs by PA levels in a Canadian population with universal health care coverage and (2) whether health care use differs among asthmatic patients based on activity levels and body mass index (BMI). We hypothesized that inactive overweight and inactive obese asthmatic patients would be greater consumers of health care.

METHODS

Participants

Data from the 2005 Canadian Community Health Survey (CCHS), cycle 3.1, a nationally representative population-based cross-sectional survey, were used. All data contained in

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the CCHS are self-reported, and respondents provide informed consent before participation. For data collection purposes, each province was divided into health regions and each territory was designated as a single health region. The CCHS provides health information for all 125 health regions, including estimates of health determinants, health status, and health system use. One of the primary objectives of the CCHS is to collect information on health system use. Detailed information on data collection methods and data weighting can be found in the user guide.¹⁹

Main Outcome and Exposure

Physician consultations and overnight hospital stays were used as a proxy for health care use. These measures were additionally chosen because they are services that are universally available to all Canadians and do not require private medical insurance. With regard to physician consultations, participants were asked the following: "Not counting when you were an overnight patient, in the past 12 months how many times have you seen, or talked on the telephone, about your physical, emotional or mental health with a family doctor, pediatrician or general practitioner?" The median number of consultations was calculated for the sample and subsequently used to dichotomize the variable into fewer than 3 consultations and 3 or more consultations. Pertaining to overnight stays, participants were asked the following 2 questions: "In the past 12 months, have you been a patient overnight in a hospital, nursing home or convalescent home?" and "For how many nights in the past 12 months?" Similar to physician consultations, the median number of overnight stays was calculated for the sample and divided into fewer than 4 nights and 4 or more nights.

The main exposure variables were PA levels and BMI. In the CCHS, participants are asked a series of questions pertaining to mode and time spent in physical activities. Because each activity is associated with a time and frequency (per week), total PA or metabolic equivalents can be calculated. The energy expenditure is based on the estimated kilocalories of energy spent per kilogram of body weight per day. A PA index is then derived to classify participants as "active" (>3.0 kcal/kg of body weight per day), "moderately active" ($1.5\text{--}3.0$ kcal/kg of body weight per day), or "inactive" (<1.5 kcal/kg of body weight per day).¹⁹ The BMI was calculated by dividing self-reported weight in kilograms by height in meters squared. All pregnant women were excluded, and BMI values above 59.9 were eliminated to minimize potential error and extreme values. Participants were then classified as underweight (BMI, <18.5), normal weight (BMI, $18.5\text{--}24.9$), overweight (BMI, $25.0\text{--}29.9$), and obese (BMI, ≥ 30.0) using standard BMI criteria. Because of the low prevalence of CCHS participants who were underweight ($n = 136$ asthmatic patients and $n = 1502$ nonasthmatic patients), analyses were subsequently limited to those whose weight was normal and above normal.

These exposure variables were then cross-classified with asthma status to create 2 new variables. The PA index cate-

gories were combined with asthma status to form inactive asthmatic patients, moderately active asthmatic patients, active asthmatic patients, inactive nonasthmatic patients, moderately active nonasthmatic patients, and active nonasthmatic patients. Similarly, BMI categories were combined with activity levels of asthmatic patients to form normal weight/active, normal weight/inactive, overweight/active, overweight/inactive, obese/active, and obese/inactive. Because of a small sample size in multivariate analyses with asthmatic patients cross-classified by BMI, the active and moderately active categories were collapsed to form the active group.

Main Covariates and Demographic Variables

The following variables were used to characterize the demographics of the sample and identify potential covariates of health care use in subsequent analyses.

Daily fruit and vegetable consumption was included because of the profound impact of proper nutrition or diet on asthma symptoms.^{20,21} It was reported and classified as "low" (<5 servings per day), "adequate" ($5\text{--}10$ servings per day), or "high" (≥ 11 servings per day). Smoker type was classified as "daily smoker," "occasional smoker," or "nonsmoker." These categories were derived by the CCHS, such that occasional smokers were either those who were self-reported former daily smokers or those who had smoked fewer than 100 cigarettes in their lives. Similarly, alcohol consumption was classified as "regular," "occasional," "former," or "never." Again, categories of alcohol consumption were derived by standard CCHS questions regarding the number of alcoholic units consumed per week and the number of times the individual had binged in a 12-month period. The presence or absence of chronic diseases (high blood pressure, heart disease, diabetes mellitus, cancer, or stroke) was also self-reported and considered for inclusion in multivariate analyses. Demographic variables included ethnicity, educational level, and annual income. Participants were asked to specify their cultural or ethnic background from 21 categories. These were subsequently dichotomized into "white" and "non-white" to account for smaller numbers within the nonwhite categories. To account for socioeconomic status, participants' highest level of education was reported as "less than secondary school," "secondary school graduate," "some postsecondary education," and "postsecondary graduate"; household income was coded as "low" ($<\text{Can}\$15,000$ if 1 or 2 people; $<\text{Can}\$20,000$ if 3 or 4 people; $<\text{Can}\$30,000$ if ≥ 5 people), "low-middle" ($\text{Can}\$15,000\text{--}\text{Can}\$29,999$ if 1 or 2 people; $\text{Can}\$20,000\text{--}\text{Can}\$39,999$ if 3 or 4 people; $\text{Can}\$30,000\text{--}\text{Can}\$59,999$ if ≥ 5 people), "upper-middle" ($\text{Can}\$30,000\text{--}\text{Can}\$59,999$ if 1 or 2 people; $\text{Can}\$40,000\text{--}\text{Can}\$79,999$ if 3 or 4 people; $\text{Can}\$60,000\text{--}\text{Can}\$79,999$ if ≥ 5 people), and "high" ($>\text{Can}\$60,000$ if 1 or 2 people; $>\text{Can}\$80,000$ if ≥ 3 people).

Statistical Analysis

All data were analyzed using SPSS statistical software, version 15.0 (SPSS Inc, Chicago, Illinois), and a master weight was applied to the data to ensure representativeness of the

sample to the Canadian population. χ^2 Tests were performed to test for differences across activity levels within asthmatic and nonasthmatic patients for all outcomes, exposures, and covariates. Multivariate logistic regression models were produced using the Enter method such that all variables were entered in a single step. Two models were run for all analyses. Model 1 adjusted for age and sex, and model 2 additionally adjusted for all other covariates. Logistic regression was used to estimate the odds ratios and 95% confidence intervals of having 3 or more physician consultations, having an overnight hospital stay, and having 4 or more overnight stays within the past year. All analyses were limited to adults between the ages of 20 and 64 years and to those without chronic obstructive pulmonary disease.

RESULTS

In total, there were 6,835 asthmatic patients (2,592 males) and 78,051 nonasthmatic patients (38,510 males) with complete data on variables of interest. Overall, 12.2% of asthmatic patients and 7.3% of nonasthmatic patients had at least 1 overnight hospital stay ($\chi^2 = 122.1$, $P < .001$) in the past year, whereas 42.4% of asthmatic patients and 38.6% of nonasthmatic patients had 4 or more overnight hospital stays ($\chi^2 = 2.5$, $P = .12$). In addition, 61.8% of asthmatic patients and 46.3% of nonasthmatic patients had 3 or more physician consultations ($\chi^2 = 295.2$, $P < .001$) within the past year.

The association between covariates and study outcomes was evaluated at the bivariate level, and all significant factors were included in the fully adjusted models. Table 1 depicts the distribution of the outcome measures and exposures. Bivariate analysis revealed significant differences in PA across all covariates, with the exception of stroke ($\chi^2 = 3.86$, $P = .15$) and cancer ($\chi^2 = 4.61$, $P = .10$) for asthmatic patients. Although most associations were intuitive, such that active individuals displayed healthier behaviors, this was not the case for alcohol consumption in either asthmatic or nonasthmatic patients. A higher percentage of active asthmatic patients and active nonasthmatic patients tended to be regular drinkers compared with inactive asthmatic patients and inactive nonasthmatic patients, respectively. Also, a lower percentage of inactive asthmatic patients and inactive nonasthmatic patients were in the high-income category, suggesting a lower socioeconomic status in the inactive group. In both asthmatic and nonasthmatic patients, a higher percentage of individuals in the inactive group used health care services compared with the active group.

Regression analyses confirm the findings at the bivariate level. There was a joint effect of inactivity and asthma such that inactive asthmatic patients were more likely to report an overnight stay and more frequent physician consultations than active nonasthmatic patients (Table 2). Inactive nonasthmatic patients were consistently at greater odds of overnight hospital stays and 3 or more physician consultations in both models 1 and 2 when compared with active nonasthmatic patients.

When examining these patterns within the sample of asthmatic patients exclusively, inactive (but not moderately active) asthmatic patients had a higher likelihood of overnight hospital stays and physician consultations than their more active peers (Table 3). A graded increase in the odds of overnight hospital stays and physician consultations was also observed across BMI/activity strata in age- and sex-adjusted analyses, with no significant relationship for the length of hospital stays (Table 4). After adjustment for additional covariates in model 2, the odds of overnight stays were higher in the inactive group regardless of BMI, whereas both BMI and PA were important determinants of physician consultations.

DISCUSSION

Our analyses confirm that asthmatic patients are more likely to use health care services than nonasthmatic patients and that inactive asthmatic patients are more likely to use health care services than active asthmatic patients. We also found that overnight hospital stays were more common in inactive asthmatic patients regardless of BMI, whereas both BMI and PA were important determinants of physician consultations.

The finding that asthmatic patients are more likely to have overnight hospital stays and 3 or more physician consultations is not surprising. Research has shown that only 19.1% of patients in the United States²² and 24% of patients in Canada²³ have well-controlled asthma according to the National Asthma Education and Prevention Program and the Canadian Asthma Consensus Guidelines, respectively. Furthermore, suboptimal control of asthma has been associated with excess health care use, such that 51% of asthmatic patients require urgent care for their asthma.²³ In addition to asthma control evaluated by physicians, perceived asthma control has also been linked to health care use. Calfee et al²⁴ showed that higher perceived control of asthma was associated with a decreased likelihood of emergency department visits and hospitalizations for asthma. Vollmer et al²⁵ have also reported a dose-response relationship between the number of asthma control problems and perceived control with physician visits, emergency department care, and hospitalization in asthmatic patients.

According to the Global Initiative for Asthma, asthmatic patients are classified as having controlled, partly controlled, or uncontrolled asthma using the following criteria: daytime symptoms, activity limitations, nocturnal symptoms, need for reliever medication, lung function (as measured by forced expiratory volume in 1 second), and acute asthma exacerbations.²⁶ Studies have shown that asthma control²⁷ and health care use²⁵ have a stronger association with the activity domain of asthma control measurement tools compared with other domains. In addition, greater perceived control is associated with fewer days of restricted activity.²⁴ In conjunction with our findings, this suggests that PA level may have a direct impact on health care use through its association with asthma control. Because physical inactivity is pervasive in North America, adoption of initiatives such as the American

Table 1. Characteristics of Patients With and Without Asthma by Physical Activity Level^a

Characteristic	Patients with asthma			Patients without asthma		
	Inactive (n = 3,400)	Moderately active (n = 1,758)	Active (n = 1,677)	Inactive (n = 38,275)	Moderately active (n = 20,072)	Active (n = 19,704)
Sex						
Male	35.5	37.2	43.6	47.8	47.7	54.0
Female	64.5	62.8	56.4	52.2	52.3	46.0
Age, y						
20–24	11.4	13.4	20.3	8.4	10.4	14.3
25–29	10.2	10.9	14.8	9.7	9.8	10.9
30–34	10.1	13.6	12.8	10.3	10.4	10.5
35–39	9.8	11.6	10.6	12.8	12.2	11.9
40–44	13.1	12.2	11.6	14.2	13.8	14.4
45–49	12.4	12.6	9.9	13.2	13.4	11.1
50–54	12.8	10.7	8.5	12.5	12.6	10.2
55–59	11.3	8.7	5.7	10.9	10.0	9.2
60–64	8.9	6.4	5.9	8.1	7.5	7.6
BMI						
Underweight (<18.5)	2.8	2.1	2.0	2.8	2.0	1.7
Normal weight (18.5–29.9)	39.5	40.5	50.1	44.8	47.0	51.0
Overweight (25.0–29.9)	29.3	35.3	30.4	33.8	35.2	35.3
Obese I (30.0–34.9)	15.6	14.8	12.1	13.2	12.1	9.4
Obese II (35.0–39.9)	8.2	5.5	4.0	3.9	2.9	2.0
Obese III (40.0–59.9)	4.6	1.7	1.6	1.4	0.9	0.5
Chronic disease						
High BP	19.2	13.5	10.0	13.2	11.5	8.7
Diabetes mellitus	7.6	4.1	2.8	4.2	3.6	2.9
Heart disease	6.8	3.6	2.2	3.2	2.6	2.3
Cancer	1.6	1.5	0.7 ^b	1.3	1.0	1.0
Stroke	1.1	0.5	0.7 ^b	0.6	0.4	0.4
Fruit and vegetable consumption, servings per day						
<5	68.4	60.0	46.5	69.4	56.9	49.0
5–10	29.0	36.3	44.4	28.4	39.6	44.6
≥11	2.6	3.8	9.1	2.3	3.5	6.4
Smoking status						
Daily	26.0	20.6	18.3	27.0	19.0	17.5
Occasional	4.7	5.8	8.0	5.1	6.0	7.0
Not at all	69.3	73.7	73.6	67.9	75.0	75.5
Alcohol consumption						
Regular	53.6	67.8	68.8	61.6	70.0	72.3
Occasional	23.5	18.1	16.1	19.0	16.7	14.7
Former	17.3	10.3	11.5	12.5	9.0	9.5
Never	5.7	3.8	3.6	6.9	4.3	3.5
Ethnicity						
White	85.8	91.6	85.3	80.7	86.1	85.1
Nonwhite	14.2	8.4	14.7	19.3	13.9	14.9
Education						
Less than secondary school	20.7	13.7	12.5	18.8	12.2	11.2
Secondary school graduate	16.9	20.0	21.2	20.4	18.9	18.7
Some post-secondary school	9.3	8.1	10.0	7.7	8.0	9.2
Post-secondary school graduate	53.2	58.3	56.4	53.2	60.9	60.9
Income						
Low	15.9	11.6	10.9	11.1	7.8	8.3
Low-middle	23.4	15.8	15.7	20.3	14.8	14.4
Upper-middle	33.6	30.0	27.4	36.5	34.8	31.8
High	27.2	42.6	45.9	32.1	42.7	45.5
Overnight stays	14.9	9.8	9.0	8.0	6.6	6.4
Length of hospital stay ≥4 nights	44.8	39.4	35.9	41.3	35.4	33.9
Physician consultations ≥3	66.0	58.1	57.5	48.6	45.3	42.7

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure.

^a Data are given as percentage of each group (and may not total 100% for each category because of rounding) and are from cycle 3.1 of the Canadian Community Health Survey. All associations between activity levels within asthmatic or nonasthmatic groups are significant unless otherwise indicated.

^b Denotes a nonsignificant χ^2 across physical activity levels of asthmatic and nonasthmatic groups.

Table 2. Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With and Without Asthma^a

Patient group	Overnight hospital stay (yes)	Length of hospital stay (≥4 nights)	Physician consultations (≥3)
Model 1			
Patients with asthma			
Inactive	2.25 (1.95–2.60) ^b	1.48 (1.12–1.96) ^b	2.43 (2.18–2.71) ^b
Moderately active	1.39 (1.12–1.73) ^b	1.33 (0.86–2.05)	1.75 (1.52–2.02) ^b
Active	1.34 (1.07–1.68) ^b	1.19 (0.75–1.88)	1.91 (1.66–2.20) ^b
Patients without asthma			
Inactive	1.24 (1.13–1.35) ^b	1.26 (1.05–1.50) ^b	1.24 (1.18–1.31) ^b
Moderately active	1.02 (0.93–1.13)	0.99 (0.80–1.22)	1.08 (1.02–1.15) ^b
Active ^c	1.00	1.00	1.00
Model 2			
Patients with asthma			
Inactive	1.75 (1.48–2.07) ^b	1.28 (0.92–1.77)	2.15 (1.90–2.44) ^b
Moderately active	1.26 (0.98–1.62)	1.22 (0.74–2.01)	1.70 (1.44–2.00) ^b
Active	1.09 (0.83–1.42)	1.02 (0.59–1.79)	1.69 (1.44–1.98) ^b
Patients without asthma			
Inactive	1.16 (1.05–1.28) ^b	1.15 (0.94–1.41)	1.12 (1.05–1.19) ^b
Moderately active	1.02 (0.91–1.14)	1.00 (0.79–1.27)	1.04 (0.98–1.11)
Active ^c	1.00	1.00	1.00

^a Data are given as odds ratio (95% confidence interval) and are from cycle 3.1 of the Canadian Community Health Survey. In model 1, data are adjusted for age and sex; in model 2, data are adjusted for age, sex, body mass index, fruit and vegetable consumption, cigarette smoking, alcohol consumption, ethnicity, educational attainment, high blood pressure, heart disease, stroke, cancer, diabetes mellitus, and annual household income.

^b $P < .05$.

^c Referent.

Table 3. Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With Asthma Only^a

Patients with asthma	Overnight hospital stay (yes)	Length of hospital stay (≥4 nights)	Physician consultations (≥3)
Model 1			
Inactive	1.68 (1.31–2.16) ^b	1.29 (0.79–2.11)	1.23 (1.04–1.46) ^b
Moderately active	1.03 (0.77–1.39)	1.13 (0.63–2.04)	0.89 (0.73–1.08)
Active ^c	1.00	1.00	1.00
Model 2			
Inactive	1.78 (1.31–2.41) ^b	1.37 (0.72–2.58)	1.26 (1.03–1.55) ^b
Moderately active	1.21 (0.85–1.72)	1.08 (0.52–2.25)	1.00 (0.80–1.25)
Active ^c	1.00	1.00	1.00

^a Data are given as odds ratio (95% confidence interval) and are from cycle 3.1 of the Canadian Community Health Survey. In model 1, data are adjusted for age and sex; in model 2, data are adjusted for age, sex, body mass index, fruit and vegetable consumption, cigarette smoking, alcohol consumption, ethnicity, educational attainment, high blood pressure, heart disease, stroke, cancer, diabetes mellitus, and annual household income.

^b $P < .05$.

^c Referent.

College of Sports Medicine's Exercise is Medicine campaign²⁸ may be particularly useful in this regard.

Our analyses pertaining to overnight hospital stays support the fit-fat concept such that activity seemed to be of greater importance than BMI per se. Compared with normal weight/active asthmatic patients, normal weight/inactive asthmatic patients were 67% more likely to have reported an overnight hospital stay in the previous year. Although obese individuals incur significantly more medical expenses and hospitalization

costs and consume more prescription medications than their lower-risk counterparts,¹⁰ previous research has shown that obesity does not necessarily affect health care use to the same extent in asthmatic patients.²⁸ Among a group of adult asthmatic patients presenting to the emergency department, the severity of the exacerbations did not differ between obese and non-obese patients.²⁹ Furthermore, in an urban pediatric population with optimal asthma control, obesity was not a factor in time to achieve control or its subsequent maintenance.³⁰

Table 4. Logistic Regression Analyses for Overnight Hospital Stays, Length of Overnight Hospital Stay, and Physician Consultations in Patients With Asthma Classified by Body Mass Index and Activity Levels^a

Patient group	Overnight hospital stay (yes)	Length of hospital stay (≥4 nights)	Physician consultations (≥3)
Model 1			
Inactive/obese	2.35 (1.69–3.27) ^b	1.61 (0.84–3.06)	2.76 (2.11–3.60) ^b
Inactive/overweight	1.75 (1.24–2.48) ^b	2.08 (1.06–4.07)	1.30 (1.02–1.65) ^b
Inactive/normal weight	1.81 (1.33–2.47) ^b	1.51 (0.81–2.81)	1.59 (1.27–1.98) ^b
Active/obese	1.48 (0.99–2.20)	1.87 (0.86–4.05)	2.18 (1.65–2.88) ^b
Active/overweight	1.18 (0.82–1.70)	1.23 (0.59–2.55)	1.29 (1.02–1.63) ^b
Active/normal weight ^c	1.00	1.00	1.00
Model 2			
Inactive/obese	1.95 (1.31–2.88) ^b	1.68 (0.75–3.74)	2.22 (1.64–3.01) ^b
Inactive/overweight	1.54 (1.03–2.30) ^b	1.53 (0.67–3.51)	1.28 (0.98–1.69)
Inactive/normal weight	1.67 (1.17–2.39) ^b	1.61 (0.76–3.45)	1.49 (1.16–1.91) ^b
Active/obese	1.13 (0.71–1.78)	1.72 (0.67–4.39)	1.81 (1.33–2.46) ^b
Active/overweight	1.16 (0.77–1.74)	1.19 (0.50–2.84)	1.23 (0.95–1.59)
Active/normal weight ^c	1.00	1.00	1.00

^a Data are given as odds ratio (95% confidence interval) and are from cycle 3.1 of the Canadian Community Health Survey. In model 1, data are adjusted for age and sex; in model 2, data are adjusted for age, sex, body mass index, fruit and vegetable consumption, cigarette smoking, alcohol consumption, ethnicity, educational attainment, high blood pressure, heart disease, stroke, cancer, diabetes mellitus, and annual household income.

^b $P < .05$.

^c Referent.

To verify that physical inactivity is indeed a moderator of health care use in asthmatic patients, prospective cohort studies of inactive asthmatic patients with variable levels of control should be conducted to monitor health care use before and after exercise interventions. Health care use measures should include emergency department visits, medication use, physician consultations, and overnight hospital stays. In addition, research pertaining to the direct relationship between asthma control and exercise is required to better understand its impact on health care use. It is also imperative that psychological conditions such as depression be carefully controlled for in such studies, because depression is closely related to both asthma³¹ and physical inactivity.³²

The greatest limitation of this study is the self-reported nature of the asthma, BMI, and PA data. Although physician-diagnosed asthma would have been preferable to reduce the possibility of misclassification bias, recent evidence suggests that physicians overdiagnose asthma in both obese and non-obese individuals.³³ Our use of self-reported height and weight as a measure of overall adiposity also likely underestimated the prevalence of overweight and obese,³⁴ whereas PA may have been overestimated by self-report.³⁵ Nevertheless, self-reported PA remains an adequate and reliable population-based measure.³⁶ Furthermore, the underreporting of BMI and overreporting of PA are likely to be equal in all groups leading to a nondifferential bias. Another limitation is that the outcome measures used did not allow us to differentiate between urgent and nonurgent care, which is an important variable to consider when assessing asthma control. Unfortunately, the CCHS does not contain a variable for emergency department visits. This is an area that should be

considered in future research. Finally, because the CCHS is cross-sectional, reverse causality cannot be ruled out. In other words, we are unable to verify whether asthmatic patients have greater health care use as a result of lower activity levels or whether they are inactive as a result of their higher health care use (ie, poorer asthma control).

In summary, results from this population-based sample of Canadians indicate that health care use is higher in adult asthmatic patients when compared with nonasthmatic patients and that both inactivity and obesity contribute to increasing health care use in asthmatic patients. Independent of BMI, active asthmatic patients are less likely to have an overnight hospital stay, whereas both BMI and PA are important determinants of physician consultations. Future research using administrative data is needed to corroborate these self-reported findings within emergency department and other health care settings.

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