Health-related Behaviours in Adults with Diabetes

Associations with Health Care Utilization and Costs

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ABSTRACT

Objectives: The primary objective of this study was to examine whether physical activity, diet, and smoking behaviours are associated with health resource utilization and costs in the Canadian context. A secondary objective was to evaluate demographic and health behavioural characteristics of the participants of the study to assess the degree of respondent bias.

Methods: Self-reported physical activity, diet and smoking status were obtained from a large population-based sample of adults with diabetes (N=2311). Resource utilization and cost information was obtained by linking these data to the provincial government's administrative database. Multiple regression models examined predictors of resource utilization and costs for individuals with type 1 (T1D) and type 2 (T2D) diabetes separately. To assess the degree of responder bias, characteristics of individuals who consented to link data were compared with those who did not consent.

Results: Various measures of health care utilization and costs were negatively associated with physical activity behaviour in both T1D and T2D groups. Ever having smoked cigarettes was associated with higher resource utilization in individuals with T2D when controlling for demographic and health variables. Significant differences in demographic and health behavioural characteristics of the participants who provided consent for data linkage and those who did not were also found.

Conclusion: These findings are of interest considering that PA is a critical but understudied component of individuals with diabetes, and this appears to be one of the first studies to directly examine the relationship between health-related behaviours and health care utilization and costs. The findings may be useful in guiding targeted health promotion programs for individuals with diabetes. The results also indicate that studies involving linkage of administrative and survey data could be over-represented by healthy individuals.

Key words: Diabetes mellitus type 1; diabetes mellitus type 2; health behaviour; health care costs

La traduction du résumé se trouve à la fin de l'article.

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The prevention and management of diabetes present large costs to the health care system, especially when considering the co-morbidities and other complications associated with this disease.[1] Treatment for those with diabetes depends on multifactorial patient-managed self-care, supported by a team of health professionals. Among these self-care activities, physical activity (PA) plays a key role in diabetes management, providing psychological and physiological benefits.[2-8] A healthy diet is another important health behaviour that facilitates effective management of diabetes.[9] Smoking behaviour, on the other hand, is a significant health risk for people living with diabetes.[10-14]

PA, diet, and smoking are three key behaviours that could potentially influence levels of resource utilization and health care costs of individuals with diabetes. The primary objective (Objective 1) of this study was to examine whether these behaviours are associated with health resource utilization and costs when controlling for other demographic and health factors that could potentially influence these outcomes. We were also interested in examining if those not meeting diabetes-specific guidelines[15] (i.e., achieving 150 minutes of moderate and/or vigorous PA per week) have higher health resource utilization and costs than those meeting guidelines.

Objective 1 necessitated linking respondents' survey results with their administrative medical records. Because not all individuals gave permission for this linkage, our secondary study objective (Objective 2) was to evaluate characteristics, both demographic and health behavioural, to assess the degree of respondent bias. Given the etiological[15] and behavioural[16,17] differences between type 1 diabetes (T1D) and type 2 diabetes (T2D), we stratified all our analyses by diabetes type.

METHODS

Study participants were part of the Alberta Longitudinal PA and Diabetes Research Advancement (ALEXANDRA) Study.[16,18] A total of 2,311 individuals with diabetes participated in this study. The study procedures, response rates, and measures are detailed elsewhere.[16] The study received institutional ethics review board approval.

Demographics and health determinants were measured using questions based on the

Statistics Canada 2001 Census,[19] and other published self-report measures.[16,17,20,21] Demographic factors assessed were age, gender (females = 2; males = 1), educational level (1 = no university degree; 2 = university degree), income and marital status (partnered = 1, single = 2). Health factors assessed were height and weight to calculate body mass index; heart disease status (assessed as having ever been told by a doctor or health care professional of having heart disease, with a "yes = 2"/"no = 1" response option); and blood pressure and cholesterol levels (also assessed as having ever been told by a doctor or health care professional of having i) high cholesterol and ii) high blood pressure, respectively, with "yes = 0"/"no = 1" response options for each question).

PA was assessed using the validated *Godin Leisure-Time Exercise Questionnaire*[22] modified to include the specific duration (in minutes) for the PA intensity categories.[16] Participants were asked to report the average number of times (frequency) and duration per week in the last month they engaged in mild (minimal effort, no perspiration), moderate (not exhausting, light perspiration) and vigorous (heart beats rapidly, sweating) PA for a minimum of 10 minutes per session. Participant responses for the three intensity categories were then converted to Met-minutes (Metabolic Equivalent minutes) by multiplying the weekly minutes of activity by 2.5 (for mild), 4.0 (for moderate) and 7.5 (for vigorous), and then summing the three scores.[16,23] Respondents were also categorized as 'active' or 'inactive' based upon achieving diabetes-specific guidelines of 150 minutes of moderate and/or vigorous PA per week.[15]

Smoking behaviour measures were used to categorize participants as current smokers, former smokers, or people who never smoked cigarettes (never smokers).[17] For this study, individuals were divided into "never smokers" and "ever smokers" ("ever smokers" being current or past smokers).

Healthy diet was measured by asking the participants on how many of the last seven days a) "have you followed a healthy diet?" b) "Did you eat five or more servings of vegetables and fruits?" c) "Did you eat high fat foods such as processed meat or full-fat dairy products?" d) "Did you space carbohydrates (e.g., bread, rice, potatoes) evenly through the day?" e) "On average, over the past month, how many days per week have

TABLE I

Multiple Regression Results for Type 1 and Type 2 Diabetes to Determine Association with Health Care Utilization and Costs

	Model 1 β (Type 1/Type 2)	Model 2 β (Type 1/Type 2)	Model 3 β (Type 1/Type 2)	Model 4 β (Type 1/Type 2)
GP Visits				
Demographic Factors				
Age	.11/.10*	–	–	-.15/.05
Gender	.19**/.12**	–	–	.22*/.06
Education	-.03/-.01	–	–	-.02/.07
Income	-.07/ -.14**	–	–	.09/-.16*
Marital status	.01/ -.10*	–	–	.16/-.08
Health Factors				
Body mass index	–	.22**/.18**	–	.26*/.16*
Heart disease status	–	.17*/.10	–	.07/.03
Blood pressure	–	.07/.17**	–	.14/.18**
Cholesterol level	–	.02/-.01	–	.07/-.00
Behavioural Factors				
Smoking status	–	–	.07/.04	.20*/.02
Physical activity	–	–	-.16**/-.08	-.08/-.06
Healthy diet	–	–	.09/-.02	.16/-.10
R^2 (Type 1/Type 2)	.06**/.05***	.10**/.09***	.04*/.01	.23**/.15***
GP Claims				
Demographic Factors				
Age	.12*/.09*	–	–	-.13/.04
Gender	.21***/.11**	–	–	.25**/.05
Education	-.02/-.01	–	–	-.02/.08
Income	-.05/-.14**	–	–	.13/-.16*
Marital status	.02/-.10*	–	–	.16/-.08
Health Factors				
Body mass index	–	.19*/.18**	–	.25**/.18*
Heart disease status	–	.19*/.11*	–	.09/.05
Blood pressure	–	.08/.16*	–	.13/.17*
Cholesterol level	–	-.01/.01	–	.04/.01
Behavioural Factors				
Smoking status	–	–	.04/.05	.17*/.03
Physical activity	–	–	-.16**/-.08	-.07/-.06
Healthy diet	–	–	.10/-.02	.16/-.09
R^2 (Type 1/Type 2)	.06**/.05***	.10**/.09***	.04*/.01	.22**/.14***
Hospital Visits				
Demographic Factors				
Age	.12/.07	–	–	-.08/.03
Gender	-.05/.00	–	–	.13/-.00
Education	.03/-.03	–	–	-.03/-.03
Income	-.05/-.03	–	–	.13/-.02
Marital status	.08/-.06	–	–	.08/-.01
Health Factors				
Body mass index	–	-.02/-.03	–	-.08/.00
Heart disease status	–	.15†/.09	–	.19*/.02
Blood pressure	–	.01/.11	–	-.08/-.06
Cholesterol level	–	.13/.08	–	-.18/.08
Behavioural Factors				
Smoking status	–	–	.09/.06	.19*/.00
Physical activity	–	–	-.10/-.08	-.06/-.09
Healthy diet	–	–	.05/-.02	-.08/-.05
R^2 (Type 1/Type 2)	.03/.01	.05/.02	.02/.01	.16*/.02
Total Number of Physician Claims				
Demographic Factors				
Age	.14*/.15**	–	–	-.05/.16*
Gender	.14*/.07	–	–	.29**/.00
Education	-.03/-.07	–	–	-.08/-.02
Income	-.08/-.07	–	–	.10/-.05
Marital status	-.04/-.07	–	–	.13/-.04
Health Factors				
Body mass index	–	.14/.04	–	.18*/.07
Heart disease status	–	.25**/.24***	–	.28**/.18*
Blood pressure	–	.05/.10	–	.04/.07
Cholesterol level	–	.10/.09	–	.13/.09
Behavioural Factors				
Smoking status	–	–	.03/.06	.13/.00
Physical activity	–	–	-.12†/-.09*	-.03/-.09
Healthy diet	–	–	.11/.02	.15/-.05
R^2 (Type 1/Type 2)	.05*/.04***	.09**/.10***	.03†/.01†	.23***/.13***

...continues/

TABLE I, continued

	Total Costs of Physician Claims			
	Model 1 β	Model 2 β	Model 3 β	Model 4 β
Demographic Factors				
Age	.18**/.14**	–	–	.05/.16*
Gender	.12*/.07	–	–	.25**/.04
Education	-.02/-.05	–	–	-.11/-.07
Income	-.02/-.02	–	–	.13/-.03
Marital status	-.06/-.05	–	–	.05/-.04
Health Factors				
Body mass index	–	.07/.00	–	.08/.05
Heart disease status	–	.21**/.26***	–	.24**/.19**
Blood pressure	–	.01/.02	–	.07/.00
Cholesterol level	–	.06/.13*	–	.06/.14*
Behavioural Factors				
Smoking status	–	–	.06/.04	.00/-.05
Physical activity	–	–	.10/-.10*	-.01/-.09
Healthy diet	–	–	.09/.04	.10/.04
R^2 (Type 1/Type 2)	.05**/.03**	.05/.10***	.02/.01*	.14/.13***

Model 1 = Demographic model; Model 2 = Health Factor Model; Model 3 = Behavioural Model; Model 4 = Full Model
Categorical variables coded as: Gender (1=male; 2=female), Education (No university=1; University=2), Marital status (Partnered=1; Single=2), Heart disease status (Yes=2; No=1), Blood pressure (Yes=2; No=1), Cholesterol (Yes=2; No=1), Smoking status (Yes=2; No=1).
† p=0.05 *p<0.05, **p<0.01, ***p<0.001

you followed your eating plan?" Item d) was reverse coded and an average of the five measures was used for the analysis.[24]

Respondents were asked to provide consent for data linkage to administrative health care data. Individuals who provided consent also provided their provincial health care number, allowing linkage of self-reported smoking and PA behaviours with information on health care resource utilization. Five specific resource use and cost variables were considered: 1) number of general practitioner (GP) visits; 2) number of GP claims; 3) number of hospital visits; 4) total number of physician claims (includes both GP and specialist claims); and 5) total costs of physician claims (total amount paid to all service providers). All administrative data were for the year 2002.

Data analysis

A series of simultaneous multiple regression analyses models were performed separately for the T1D and T2D groups to assess the relationship between demographic, health and behavioural factors, associated with each of the five indices of resource utilization and costs. These models examined the association of each independent variable in a given model with the dependent variable (resource utilization and costs), when adjusted for all other variables in the model. Beta weights (β weights: standardized beta coefficients) associated with each of the variables were examined. For all analyses, age, body mass index, Met-minutes and healthy eating were treated as continuous measures; all other factors were categorical variables (see footnote in Table I). The first regression analysis (the Demographic model) included the demographic factors of age, gender, marital status, education and income. The second model (the Health Factor model) included the health factors of body mass index, heart disease status, blood pressure level and cholesterol level. The third (Health Behavioural model) included smoking status, physical activity and healthy diet. The fourth model (the Full model) included all demographic, health and behavioural factors.

Further, as a subsidiary analysis, for each of the diabetes groups, one tailed t-tests were performed to determine if those achieving diabetes-specific guidelines of 150 minutes of moderate and/or vigorous PA per week[15] had higher resource utilization and costs than those who did not achieve this criterion.

To assess the degree of respondent bias (our secondary objective), demographic (age, sex, education category, and marital status category) and health behaviour characteristics ('active' or 'inactive' based on the diabetes PA guidelines,[15] current smoking status, healthy eating and BMI) were compared for those who did and did not consent to the record linkage. Independent-samples t-tests and chi-square analyses were conducted for continuous and categorical variables respectively.

RESULTS

Of the total of 2,311 participants (697 T1D and 1,614 T2D), 377 (54%) and 855 (53%) T1D and T2D individuals, respectively, consented to have their Alberta Health and Wellness resource utilization and cost data linked to their study data. The demographic characteristics of our study generally reflect Canada's diabetic population in terms of age and sex distributions (Table II).[16,25] Provincial government data could not be traced for some of the individuals who provided consent. Linked data were available for 319 individuals with T1D (58 lost cases) and 706 individuals with T2D (149 lost cases).

Objective 1

The explained variances for the different models (R^2 values), β weights and the significance associated with each of the variables are displayed in Table I.

In our subsidiary analysis, a higher number of GP visits (t=1.79; p<0.05), GP claims (t=1.62; p=0.05), hospital visits (t=3.18; p<0.01), physician claims (t=2.81; p<0.01), and total costs of physician claims (t=2.80; p<0.01) was found for T2D individuals not achieving PA guidelines. For T1D, a higher number of GP visits (t=1.6; p=0.05) and GP claims (t=2.04; p<0.04) was observed for individuals not achieving PA guidelines.

Objective 2

Table II also provides t-test values, chi-square values and their associated significance that compare those who did and did not consent to the record linkage.

DISCUSSION

Within a Canadian context, this study examined if PA, healthy eating and smoking influence resource utilization in people with type 1 or type 2 diabetes. We are unaware of any studies that directly examined the relationship between health-related behaviours and health care utilization and costs in individuals with diabetes.

This study provides evidence of higher resource utilization and costs in individuals who do not meet minimum PA guidelines. This is especially evident for T2D individuals, where all five of the resource utilization and cost variables examined were significantly lower in individuals achieving PA guidelines. For T1D, however, being inactive was only marginally associated with GP and hospital visits. Although solid conclusions cannot be drawn from these results

TABLE II

Characteristics of Study Participants

		Type 1 Diabetes (N=697)			Type 2 Diabetes (N=1614)			Participants Successfully Linked to Alberta Health Database	
		Agreed to Link Data (n=377)	Did Not Agree to Link Data (n=320)		Agreed to Link Data (n=855)	Did Not Agree to Link Data (n=759)			
		Mean (SD)	Mean (SD)	Test of Significance	Mean (SD)	Mean (SD)	Test of Significance	Type 1 Diabetes (n=319) Mean (SD)	Type 2 Diabetes (n=706) Mean (SD)
Age (years)		52.5 (16.8)	49.5 (17.4)	t = 2.29 p<0.05	63.8 (11.6)	62.0 (12.6)	t = 2.90 p<0.01	52.2 (17.0)	64.0 (11.6)
Duration of diabetes		22.1 (13.2)	20.0 (13.0)	t = 2.10 p<0.05	11.2 (13.2)	11.3 (12.7)	t=-.247 p=0.80		
BMI (kg/m^2)		26.3 (4.5)	26.3 (4.6)	t = .06 p=0.95	29.4 (6.2)	30.2 (6.4)	t = -2.55 p<0.05		
Healthy eating (days/week)		5.6 (1.2)	5.3 (1.4)	t = 3.08 p<0.01	5.4 (1.3)	5.2 (1.4)	t = 3.50 p<0.001		
		n (%)	n (%)		n (%)	n (%)		n	n
Gender	Male	174 (25)	149 (21)	χ^2 = .01 p=0.91	448 (28)	381 (24)	χ^2 = .78 p=0.38	150	357
	Female	203 (29)	171 (25)		407 (25)	378 (23)		169	349
Education level	No University	205 (30)	181 (26)	χ^2 = .45 p=0.51	542 (34)	542 (34)	χ^2 = 3.67 p=0.06	171	445
	University	167 (24)	133 (19)		308 (19)	308 (19)		144	256
Marital status	Single	105 (15)	88 (13)	χ^2 = .00 p=0.95	186 (12)	193 (12)	χ^2 = 3.19 p=0.07	89	155
	Partnered	269 (39)	228 (33)		667 (42)	561 (35)		228	549
Current/ past smoker	Yes	29 (4)	29 (4)	χ^2 = .43 p=0.51	52 (3)	71 (4)	χ^2 = 5.96 p<0.05	161	395
	No	347 (50)	290 (42)		795 (50)	685 (43)		153	281
Activity level†	Active	161 (23)	131 (19)	χ^2 = .22 p=0.64	343 (21)	225 (14)	χ^2 =19.34 p<0.001	136	287
	Inactive	216 (31)	189 (27)		512 (32)	534 (33)		183	419

† Activity level according to Canadian PA guidelines.

alone, it appears achieving PA guidelines is perhaps more important from a health care perspective for T2D compared to T1D individuals. This finding is in line with the evidence that lifestyle factors such as PA are more important for T2D than for T1D,[26] and is also of interest considering that PA is a critical but understudied component of the self-care regimen for those with either T1D or T2D.[27] This study also suggests that simply expending energy through any activity (i.e., not necessarily meeting guidelines) may influence resource utilization and costs in these groups. In the Behavioural model, PA measured by Met-minutes was significantly associated with GP visits, GP claims, and the number of physician claims for T1D when controlling for smoking and healthy eating. For T2D, this PA measure was significantly associated with the number of physician claims, and total costs of physician claims.

In examining smoking behaviour, the Full model suggests that having ever smoked cigarettes (current or past) is significantly associated with GP visits, GP claims and hospital visits for T1D individuals. This finding is not surprising considering the vast body of evidence that links smoking to many health problems and chronic conditions.[10,11] However, we were somewhat surprised that 'having ever smoked cigarettes' was not related to health care utilization in T2D. One explanation for this finding could be that a significant proportion of the smokers in our study (type 2 individuals) did not provide consent for data linkage (discussed below), and therefore were excluded from our regression models. Further, our sample consisted of fewer current smokers than what has been reported for the Canadian population living with diabetes.[28]

Although the examination of demographic and health factors was not the main focus of this study, it is worthwhile to comment on these results. Older age was associated with health care utilization for both T1D and T2D individuals when controlling for other demographic factors. For T1D, age was found to be a significant correlate of GP claims, total number of physician claims and the total costs of physician claims. For T2D, GP visits were also associated with older age. This finding is expected when considering that most health-related problems develop with advancing age.

Gender was also significantly associated with health care utilization, with females utilizing more resources. This was observed in T1D only, and may indicate child-bearing-related costs, as the T1D group was younger than the T2D group. Marital status was marginally associated with resource utilization, where married individuals utilized more resources. This was observed only for T2D.

Income was negatively associated with both GP visits and GP claims, in both the Demographic and Full models for individuals with T2D. Our findings are consistent with other research which shows that a lower socio-economic status is known to be associated with diabetes-related complications,[29] and health-promoting behaviours are more common among people with higher incomes.[30]

Previous researchers have found substantial health care costs associated with those who are overweight and obese.[31] For both T1D and T2D, this study found that BMI was associated with higher number of GP visits and GP claims in the Health Factor model and the Full model. For T1D, BMI was also related to the number of physician claims in the Full model. Heart disease for both T1D and T2D, and blood pressure and cholesterol level for T2D, were other health factors positively associated with health care utilization.

Strengths of the present study include the large sample employed, and analyzing data separately for the two diabetes groups. Some limitations of this study, however, should be acknowledged. The comparison of characteristics of individuals who consented to the Alberta Health data linkage with those who did not provide consent (our second study objective) suggests that linkage of administrative and survey data could be over-represented by healthy individuals, and suggests a potential threat to the internal validity of research when studies rely on individuals who provide voluntary consent to participate. Other limitations of this study include the reliance of self-report for lifestyle behaviour and health factor assessments (including the correct classification of type 1 and type 2 diabetes) and the correlational study design.

Despite the limitations of the study, our findings will be useful in guiding targeted health promotion programs for individuals with diabetes, and is one of the first studies to examine the relationship between health-related behaviours and health care utilization and costs, and to assess the characteristics and potential bias of individuals consenting to data linkage in a diabetes population.

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RÉSUMÉ

Objectifs : Notre étude visait principalement à déterminer si l'activité physique, le régime et l'usage du tabac sont associés à l'utilisation et aux coûts des ressources en santé dans le contexte canadien. Accessoirement, nous avons analysé le profil démographique et les habitudes de santé des participants de l'étude pour déterminer l'importance du biais statistique.

Méthode : Nous avons obtenu des données auto-déclarées sur l'activité physique, le régime et l'usage du tabac auprès d'un vaste échantillon représentatif d'adultes diabétiques (n=2 311). Les données sur l'utilisation et les coûts des ressources ont été obtenues en effectuant des maillages avec la base de données administratives du gouvernement provincial. À l'aide de modèles de régression multiple, nous avons examiné les variables prédictives de l'utilisation et des coûts des ressources pour les personnes atteintes du diabète de type I (DT1) et pour celles atteintes du diabète de type II (DT2). Pour déterminer le biais statistique, nous avons comparé les caractéristiques des personnes ayant consenti à nous donner accès à leurs données administratives et celles des personnes n'ayant pas donné leur consentement.

Résultats : Diverses mesures de l'utilisation et des coûts des soins de santé étaient liées négativement à l'activité physique dans les deux groupes (DT1 et DT2). Compte tenu des effets des variables démographiques et de santé, le fait d'avoir déjà fumé la cigarette était associé à une plus forte utilisation des ressources chez les personnes ayant le DT2. Nous avons également observé des écarts significatifs dans le profil démographique et les habitudes de santé des participants ayant consenti au maillage des données et de ceux qui n'y ont pas consenti.

Conclusion : Ces constatations sont intéressantes, car l'activité physique est un élément crucial, mais insuffisamment étudié, du profil des personnes diabétiques, et notre étude semble être l'une des premières à avoir examiné directement la relation entre les habitudes de santé et l'utilisation et les coûts des soins de santé. L'étude pourrait donc servir à orienter les programmes de promotion de la santé qui ciblent les diabétiques. Il semble aussi, d'après nos résultats, que les sujets en bonne santé pourraient être sur-représentés dans les études qui comportent des maillages de données administratives et de données d'enquête.

Mots clés : diabète de type I; diabète de type II; habitudes de santé; coûts des soins de santé