

Canadian Journal of Diabetes

IN THIS ISSUE

Original Research

- 250** Efficacy of A1C Reduction Using Internet Intervention in Patients with Type 2 Diabetes Treated with Insulin
- 254** Body Mass Index and Food and Nutrient Intake of Children with Type 1 Diabetes and a Carbohydrate Counting Meal Plan
- 262** Primary Care Physician Referral Patterns to Diabetes Education Programs in Southern Ontario, Canada
- 269** Diagnosis and Management of Obesity: A Survey of General Practitioners' Awareness of and Familiarity with the 2006 Canadian Clinical Practice Guidelines
- 274** Predicting the Future Burden of Diabetes in Alberta from 2008 to 2035
- 282** Pharmacists' Anticipated Pain Compared to Experienced Pain Associated with Insulin Pen Injection and Fingertip Lancing
- 287** Development and Pilot-Testing of a Brief Psychosocial Group Intervention Protocol for Type 2 Diabetes Self-Management

TABLE OF CONTENTS

Canadian Journal of Diabetes**Editor's Note**

- New Insights in the Prevention and Early Management of Type 2 Diabetes 239
D.C.W. LAU

Research Update

- The Canadian Diabetes Association Invests \$7.2 Million in Research to Lead the Fight Against Diabetes 242
J. SUNDARAMOORTHY

Editorial

- Diabetes Clinical Practice: Same Evidence-Based Medicine, Two Different Guidelines 243
M. AZAR, J.-M. ÉKOÉ, R. RABASA-LHORET

Diabetes and Society

- Re-engineering Steps Into Daily Life: A Critical Issue in Diabetes Management 245
K. DASGUPTA

Position Statement

- Use of Glycated Hemoglobin (A1C) in the Diagnosis of Type 2 Diabetes Mellitus in Adults 247
R. M. GOLDENBERG, A.Y.Y. CHENG, Z. PUNTHAKEE, M. CLEMENT

Original Research

- Efficacy of A1C Reduction Using Internet Intervention in Patients with Type 2 Diabetes
Treated with Insulin 250
H. D. TILDESLEY, A. B. MAZANDERANI, J. H. M. CHAN, S. A. ROSS
- Body Mass Index and Food and Nutrient Intake of Children with Type 1 Diabetes
and a Carbohydrate Counting Meal Plan 254
V. BLOUIN, I. BOUCHARD, I. GALIBOIS
- Primary Care Physician Referral Patterns to Diabetes Education Programs in Southern Ontario, Canada 262
E. GUCCIARDI, V. W.-S. CHAN, M. FORTUGNO, S. KHAN, S. HORODEZNY, S. J. SWARTZACK
- Diagnosis and Management of Obesity: A Survey of General Practitioners' Awareness
of and Familiarity with the 2006 Canadian Clinical Practice Guidelines 269
H. PICCININI-VALLIS
- Predicting the Future Burden of Diabetes in Alberta from 2008 to 2035 274
R. S. LAU, A. OHINMAA, J. A. JOHNSON
- Pharmacists' Anticipated Pain Compared to Experienced Pain Associated with Insulin Pen Injection
and Fingertip Lancing 282
S. A. DIAMOND, I. MATOK
- Development and Pilot-Testing of a Brief Psychosocial Group Intervention Protocol
for Type 2 Diabetes Self-Management 287
B. C. SABOURIN, T. M. VALLIS, S. CURRIE

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Mandate

The mission of the *Canadian Journal of Diabetes* is to promote the sharing of multidisciplinary research and evidence-based knowledge, from clinical science to public health and education, which leads to advances in the care of diabetes.

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EDITOR'S NOTE

New Insights in the Prevention and Early Management of Type 2 Diabetes

The Public Health Agency of Canada (PHAC) and the Canadian Institute for Health Information (CIHI) recently released a joint report, entitled "Obesity in Canada," which contains new analyses of the prevalence, determinants and impact of obesity in Canada (1). There were few surprises on the measured weight and height data from 2007 to 2009. Obesity rates roughly doubled across all age groups up to age 65 between 1981 and 2009, and we are less physically fit!

Canadian youths and adults are heavier than ever. More than 1 in 4 Canadian adults and 1 in 11 children and youths aged 6 to 17 are obese (1). The highest prevalence is in Newfoundland and Labrador (25.4%) with lower rates as we move to the west coast, and the lowest rate of 12.8% in British Columbia. The statistics are even more alarming for Aboriginal peoples, with 36% considered obese. Canada's overall obesity prevalence rate of 25.5% ranks fourth among countries in the Organisation for Economic Co-operation and Development, better than the United States (US;34.3%), Mexico (30%) and New Zealand (26.5%), but worse than the United Kingdom (24%). In contrast, the obesity rate is only 3.4% in Japan (1). Nonetheless, adiposity is a global public health concern.

Since 1980, systematic analysis of health examination surveys and epidemiologic studies with 960 country years and 9.1 million people have confirmed a steady increase in body mass index (BMI) for adults over age 20 years for most countries (2). From 1980 to 2008, the age-standardized mean BMI increased globally by 0.4 kg/m² per decade for men and 0.5 kg/m² per decade for women. In 2008, an estimated 1.46 billion adults (1.41 to 1.51 billion) worldwide were overweight or obese (BMI ≥25 kg/m²); of these, 205 million men (193 to 217 million) and 297 million women (280 to 315 million) were obese (2). Both the Canadian and global trends in obesity call for interventions and policies to curb or reverse the rising prevalence and to target the health complications associated with increasing adiposity.

The joint PHAC–CIHI report suggests that improving the health behaviour of Canadians by increasing low-impact physical activity by 15 minutes daily, along with encouraging more vegetable and fruit consumption, could reduce the equivalent of over 1 million cases of obesity. In addressing the obesogenic environment, the report outlined 3 broad strategies to combat the pandemic of obesity in Canada. The first is aimed at health services and interventions that target individuals. The second is community-level interventions that directly influence individual and group health

behaviour, and third is to develop public policies that target broad social and environmental determinants. Clearly, a comprehensive, multifaceted approach combining the individual, community and population levels will be most effective in reducing the prevalence of obesity and its attendant health complications.

As health professionals, we have long advocated and preached to our clients to eat less and exercise more. Just how much less food (calorie) consumption and how much more activity are required to prevent weight gain were the subject of a recent report (3). Three separate cohorts of over 120 000 men and women followed for 20 years gained an average of 3.35 lb (1.5 kg) over each 4-year interval. Potato chips and sugar-sweetened beverages accounted for weight gain of 1.69 lb (0.76 kg) and 1 lb (0.45 kg), respectively, whereas fruit and vegetable intake were associated with weight loss of 0.49 lb (0.22 kg) and 0.22 lb (0.01 kg), respectively. Physical activity was associated with weight loss of 1.76 lb (0.79 kg), and TV watching led to weight gain of 0.31 lb (0.14 kg)/h/day. The authors concluded that a habitual energy imbalance of 50 to 100 kcal/day daily would be sufficient to result in the gradual weight gain seen in most of the study participants. A daily 100-kcal deficit would result in a 10 lb (4.5 kg) weight loss in a year. Hence, modest but sustained health behavioural modification through individual- or population-based strategies directed at specific dietary and physical activity changes could prevent obesity over the long term (3).

Excess body fat and, notably, abdominal adiposity greatly increase the risk for insulin resistance, type 2 diabetes in susceptible individuals, cardiovascular disease, musculoskeletal disease, cancer, and all-cause mortality (4,5). Available data from Ontario and Alberta suggest that the rising prevalence of type 2 diabetes is fuelled by the pandemic of obesity, and similar extrapolations probably extend to other provinces and territories across the country (6). Canada, the US and other developed countries will face an alarming increase in the burden of diabetes and cardiovascular disease. In 2010, over 2 million Canadians and close to 19 million Americans were diagnosed with diabetes, and a large number of people had undiagnosed diabetes (7,8). Importantly, the US Centers for Disease Control and Prevention estimated that close to 80 million Americans had prediabetes. With a conversion rate of 7 to 9%/year, it can be predicted that a tsunami of type 2 diabetes in North America is imminent. Each year about 6 million

people develop diabetes worldwide with a vast majority having type 2 diabetes.

Several large-scale randomized, double-blind trials provide compelling and irrefutable evidence that intensive lifestyle intervention is highly effective in the prevention of diabetes among people with prediabetes, and that the benefits of lifestyle changes persisted for many years (9-11). A mere 1.2% body weight loss (just over 1 kg or nearly 3 lb/year) over 4 years reduced the risk for diabetes by 58%, and the health benefits of modest weight loss persisted for over 10 years (9-11). Alternatively, metformin (the most widely prescribed anti-diabetic medication) lowered diabetes risk by 31%, and its effects on diabetes risk reduction also persisted (11). Unfortunately, translation and implementation of these intensive trial program designs into community and primary-care settings have posed significant challenges. Two recent studies, the Finnish National Diabetes Prevention Program (FIN-D2D) and Healthy Living Partnerships to Prevent Diabetes (HELP PD) Project have reported favourable interim results (12,13). Diabetes risk reduction was 69% for the 18% of participants who lost $\geq 5\%$ weight and 28% in the group who lost 2.5 to 4.9% (12).

The ongoing National Institutes of Health-sponsored multicenter Look AHEAD (Action for Health in Diabetes) trial, the design of which is based largely on the US Diabetes Prevention Program, is investigating the effects of lifestyle intervention on changes in weight, fitness and cardiovascular disease risk factors and events in people with type 2 diabetes. The 1- and 4-year interim data reported beneficial effects of modest weight loss of 5 to 10% in improving glycemic control and the lowering of cardiovascular risk markers, blood pressure and lipid levels (14-16). Greater improvement in risk factors occurred with greater weight losses (16). Whether lifestyle behavioural changes translate into reduction in cardiovascular disease events will await the completion of this trial over the next several years.

What do we know about the benefits of health behavioural changes in people newly or recently diagnosed with type 2 diabetes? The effects of intensive dietary intervention (6.5 h of additional dietary counselling beyond usual care) or diet and physical activity on glycemic and blood pressure control were the aim of the 52-week Early Activity in Diabetes (Early ACTID) trial conducted in the UK (17). Intensive dietary intervention lowered glycosylated hemoglobin (A1C) (-0.28% and -0.26%) and body weight (-0.7 kg and -0.5 kg) from baseline, whereas A1C deteriorated in the usual care (control) group at 6 and 12 months, respectively. Diet plus physical activity (30 min of brisk walking at least 5 days/week) also improved glycemic control and weight loss, but was not significantly different from dietary intervention alone at 6 or 12 months (17). Blood pressure values were similar in

all 3 groups. Further study is needed, to determine whether more intense or different types of physical activity (aerobic plus resistance) would improve glycemic control and other metabolic parameters.

Another study investigated early, intensive, multiple cardiovascular risk factor management on 5-year cardiovascular outcomes in people with type 2 diabetes identified through random screening (18). Compared with routine care, intensive treatment to a guideline target resulted in a lowering of systolic blood pressure by 12 mm Hg, a 1.2 mmol/L reduction in low-density lipoprotein cholesterol and a 17% reduction in the incidence of cardiovascular events. It should be pointed out that the event rate was less than predicted in the routine care arm, suggesting a lack of power in the original study design (18).

What are the lessons learned from these recent studies? First, adiposity and notably abdominal obesity are powerful risk factors for type 2 diabetes. Effective interventions at the individual, community and population levels are required not only to change health behaviour but also the obesogenic environment to reduce the prevalence of obesity and its associated health risks. The three P's—the *public*, *policy* makers and enabling health *policies*—will need to be aligned for successful outcomes.

Second, early and intensive health behavioural changes are strongly recommended in people who are at high risk for the development of diabetes.

Third, a modest weight loss of even 5 to 10% through dietary modification and physical activity is highly beneficial in diabetes prevention. The magnitude of diabetes risk reduction is proportional to the degree of weight loss and health behavioural changes.

Fourth, in offering advice to our clients, we should focus on modifying those specific dietary and health behaviours that are associated with long-term weight gain. Available data suggest that, while beneficial in improving cardiovascular fitness and overall health, physical activity focusing on weight loss provides greater benefits in reducing the risk of diabetes in overweight and obese people.

Finally, appropriate screening, early diagnosis and management of cardiovascular risk factors in people with type 2 diabetes might reduce cardiovascular morbidity and mortality over the long term.

Ongoing trials will lend further insights into the potential cardiovascular benefits of health behavioural changes in overweight people with type 2 diabetes. Much work needs to be done by all of us to achieve the lofty goal of reducing the health and economic burden of diabetes.

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RESEARCH UPDATE

The Canadian Diabetes Association Invests \$7.2 Million in Research to Lead the Fight Against Diabetes

In 2011–2012, the Canadian Diabetes Association (CDA) will be funding 110 health research grants and awards across Canada, for a total investment of \$7.2 million. This investment demonstrates the CDA's commitment to investing in excellence in science and innovation. The research being supported will help address important issues relating to the prevention, management and treatment of diabetes; prevention and treatment of diabetes-related complications; and possibly even a cure. In addition to directly funding research projects, the CDA is partnering on 3 different initiatives that will enable additional diabetes research to be carried out in Canada.

Table 1 provides a summary, by category, of the grants and awards funded by the CDA in 2011–2012; research is funded from July 1, 2011 to June 30, 2012. Below are some examples of the new projects funded.

<i>Type of award</i>	<i>New/ renewed in 2011–2012</i>	<i>Ongoing commitments (awarded in previous competitions)</i>	<i>Total</i>
Operating grants	27	36	63
Personnel awards			
Clinician scientists	1	6	7
Scholars	1	6	7
Post-doctoral fellows	10	10	20
Doctoral students	7	6	13
Total	46	64	110

DR. TIMOTHY KIEFFER **UNIVERSITY OF BRITISH COLUMBIA**

Dr. Kieffer will be exploring whether it is possible to cure diabetes by stimulating the body to produce more beta cells, while also protecting the cells from high levels of fats (type 2 diabetes) and attack by the immune system (type 1 diabetes). It has recently become possible to deliver therapeutic genes directly and specifically to the pancreatic beta cells using a viral vector. Importantly, the majority of humans are naturally exposed to this type of virus without any known symptoms, and based upon this perceived safety profile, the virus is being used in many clinical trials. Dr. Kieffer will use this viral vector to deliver glucagon-like peptide 1 (GLP-1) to beta cells to improve their survival and function, and indoleamine 2,3-dioxygenase (IDO) to protect them from immune attack. He will test the effectiveness of these

treatments in mice with type 1 diabetes. If successful, this innovative approach could ultimately lead to new strategies to cure diabetes.

DR. REMI RABASA-LHORET **INSTITUT DE RECHERCHES CLINIQUES DE MONTRÉAL**

Dr. Rabasa-Lhoret will be carrying out clinical tests of a closed-loop approach that would regulate blood glucose levels for patients with type 1 diabetes. Each study participant will visit the clinical research facility twice. His/her glucose levels will be regulated once by the closed-loop strategy and once using conventional insulin pump therapy. At each visit, study participants will be asked to perform exercise, eat dinner and spend the night at the research facility. Exercise-induced and nocturnal hypoglycemia are common events in patients with type 1 diabetes, even if preventive actions are taken. The overall goal of this research is to clinically test a bi-hormonal (insulin and glucagon) “closed-loop” approach to regulate blood glucose levels.

DR. JOAN KREPINSKY **MCMASTER UNIVERSITY**

Dr. Krepinsky will investigate how transforming growth factor beta (TGF-beta) activates sterol regulatory element-binding protein 1 (SREBP-1), and how this contributes to an increase in scar proteins in people with diabetic kidney disease. Her research will shed light on how TGF-beta activates SREBP-1 in kidney mesangial cells, and how SREBP-1 induces these cells to make scar protein in response to TGF beta. She will test to see whether inhibition of SREBP-1 will limit TGF-beta production and prevent diabetic kidney disease in mice. Preventing or slowing the accumulation of scar proteins is important for preserving kidney function in people with diabetes, and blocking SREBP-1 may be a new way of achieving this.

The CDA is proud to be supporting the best ideas from the brightest minds in diabetes research in Canada. For a complete list of new grants and awards funded in the 2011 research competition, visit www.diabetes.ca/for-professionals/research/grants-awards/.

Jovita Sundaramoorthy
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EDITORIAL

Diabetes Clinical Practice: Same Evidence-Based Medicine, Two Different Guidelines

“We don’t see things as they are, we see them as we are,” as it has been said (1), should not in theory be applicable to evidence-based guidelines. However, the Canadian Diabetes Association (CDA) guidelines (2) and the American Diabetes Association/European Association for the Study of Diabetes (ADA/EASD) consensus statement (3) differ substantially, even though they relied on the same evidence-based literature at the time they were updated (2008–2009). What are the main differences, and can we explain such discrepancies?

Although both guidelines stress the importance of lifestyle modifications and the early introduction of metformin, significant differences emerge in second-line therapies. In the Canadian guidelines, all therapeutic classes are considered equal treatment options that should be individualized based on potency and side effects, such as hypoglycemia and weight gain. However, in the ADA/EASD consensus statement, treatment options are divided into two tiers: the first, which suggests the addition of either sulfonylurea or insulin to metformin, and the second, which includes a thiazolidinedione (TZD)—pioglitazone, but not rosiglitazone—and glucagon-like peptide-1 agonists. The latter is intended to be used when hypoglycemia or weight loss are of significant concern. Other options such as glinides, alpha-glucosidase inhibitors and dipeptidyl-peptidase 4 inhibitors are listed without specific indications.

What are the reasons behind such discrepancies? One has to consider the philosophy underlying the guidelines. The CDA guidelines “facilitate the ability of clinicians ... and society in general to critically examine any recommendation and arrive at their own conclusions regarding its appropriateness” (2). The ADA/EASD consensus experts believe that “in all clinical decision-making, an evidence-based review of the literature must also be supplemented by value judgments” (3). Therefore, their recommendations were also based on their “collective knowledge and clinical experience” (3). In fact, Canadian guidelines rely exclusively on a standardized evaluation of the literature by a large group of healthcare experts in order to minimize biases, whereas the ADA/EASD adopted an approach that is based on a key-opinion-leaders approach in which clinical judgment was used to overcome literature limitations. Consequently, this leads to distinct diabetes treatment algorithms—one that favours personalized treatment with many drug options, while the other is far more directive.

On the other hand, diabetes management is challenging

because it must take into account the biologic and psychosocial aspects of the patient at various stages of the disease. The major factors considered for the choice of an antihyperglycemic agent are given different levels of importance in these guidelines. The ADA/EASD consensus statement gives more weight to medication potency and pill cost, which subsequently limits the use of new expensive options compared to metformin, sulfonylurea and insulin. The cost issue was not included in the CDA guidelines because the authors believed that cost-effectiveness should encompass more factors than pill cost. On the other hand, the CDA underscores hypoglycemia risk, weight gain and patient preference. However, it should be acknowledged that aside from weight gain (an easily measurable variable), all other factors that could be taken into consideration to evaluate the benefit-to-risk ratio of various options are either not supported by high-quality evidence or are prone to subjectivity. In brief, medication options vary according to different purposes and priorities—the latter depending on the importance given to biologic, psychologic and social aspects of diabetes treatment.

Recommendations are also influenced by the attitude of the medical community toward uncertainties in clinical research. When confronted with mixed evidence, one will tend to search for evidence of one’s own point of view in supportive studies and for flaws in contradictory studies (4). The ongoing debate on the cardiovascular safety of TZDs is a good example of different attitudes towards risk tolerance, especially when other therapeutic options are available.

Same evidence, different conclusions: a striking reality! On which guidelines should clinicians rely then? It is impossible to answer, since no large randomized controlled trials have ever tested strategies proposed by various organizations. As clinical research is constantly evolving, new guidelines are developing and contrasting recommendations will be hard to reconcile. It is time for physicians to become acquainted with factors involved in guideline initiation, development and implementation in order to critically compare them (5). Despite available guidelines, medicine will remain an art, and interpretation of results, a daily challenge. Diabetes treatment is, and will remain, challenging for both patients and physicians.

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14th Annual CDA/CSEM Professional Conference and Annual Meetings

SYMPOSIUM: DIABETES FOR THE PRIMARY CARE PRACTITIONER

Date: Saturday, October 29, 2011

Time: 9:00am-12:00pm

Location: Metro Toronto Convention Centre-South Building, Toronto, Ontario

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One day free registration will be provided to family doctors to attend this symposium on Saturday. Primary Care Practitioner Symposium topics include:

- | | |
|----------------|--|
| 9:00am-12:00pm | Update on Pharmacotherapy
Intensification of Insulin
Vascular Protection Beyond Glycemic Control
Pregnancy and Diabetes |
| 1:00pm-2:00pm | Update on the 2013 CDA Clinical Practice Guidelines |

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DIABETES AND SOCIETY

Re-engineering Steps Into Daily Life: A Critical Issue in Diabetes Management

The 21st century ushered in an era of Internet transactions, “smart” phones and social networking, reducing “incidental” physical activity and contributing to escalating rates of obesity and its detrimental consequences—diabetes, hypertension and, ultimately, arterial disease. Activities that required some minimal amount of walking (e.g. mailing a letter, withdrawing money from the bank, shopping) may now be done with a few keystrokes. The loss of these daily steps is of importance not only in terms of diabetes risk, but also in terms of vascular disease risk among individuals with established type 2 diabetes. The happy corollary is that higher walking levels offer the potential for vascular risk reduction. For example, as demonstrated in the National Health Interview Survey by Gregg and colleagues (1) and the Nurses’ Health Study (2), the independent effects of higher walking levels accounted for a >30% reduction in mortality among patients with diabetes and/or hypertension.

The challenge that diabetes patients, healthcare practitioners and society face is the reintegration of walking into daily life. Measurement and monitoring of walking in real time is now possible through devices such as pedometers. Pedometers (step counters) record hip flexion movement and thus “count” steps. Much of the seminal work on pedometer-based measurement in diabetes was conducted by Canadian scientist Dr. Catrine Tudor-Locke and colleagues. Their First Step Program trial (3) demonstrated that among adults with type 2 diabetes, pedometer-based self-monitoring combined with 4 group counselling sessions could lead to a 2000 steps/day increment with a suggestion of improvements in blood pressure, although the study was underpowered to confirm an impact on blood pressure. These findings are consistent with a meta-analysis of 8 clinical trials (1 in type 2 diabetes, 3 in other chronic diseases, 4 in sedentary/overweight individuals), which indicated that group-based pedometer interventions led to a 2491 daily step increase (95% CI 1098 to 3885) and a -3.8 mm Hg change in systolic blood pressure (95% CI -5.9 to -1.7) (4). While these findings are promising in terms of the potential impact of pedometer-based strategies, group-based counselling approaches cannot be easily integrated into clinical practice.

To gain a better understanding of step-count patterns and relationships with vascular disease risk factors, I led a 201-person observational cohort study wherein adults with type 2 diabetes were assessed up to 4 times over a 1-year period. We determined that daily step counts were

low overall and fell even further during the fall and winter months. Specifically, mean daily step counts were 5731 (SD 2788) during the spring/summer months and decreased to 4937 (SD 2731) during fall/winter (5). As a benchmark, a widely used classification of daily step counts categorizes individuals achieving <5000 steps/day as sedentary; 5000 to 7499 as low active; 7500 to 9999 as somewhat active; and $\geq 10\,000$ as active (6). Our participants were thus, on average, at a low active level during the spring/summer and at a sedentary level during fall/winter.

Analyses of our data did demonstrate the association of higher step counts with lower-risk vascular profiles. In age and ethnicity-adjusted models, a 1000 steps/day increment among women was associated with a -2.6 mm Hg (95% CI -4.1 to -1.1) change in systolic and a -1.4 mm Hg (95% CI -2.2 to -0.6) change in diastolic blood pressure. Among men, corresponding changes were -0.7 mm Hg (95% CI -2.1 to 0.7) and -0.6 mm Hg (95% CI -1.4 to 0.3), respectively (7). Notably, this relationship was unaffected by adjustment for use of antihypertensive agents, suggesting that blood pressure follow-up may be a means of capturing the biological impact of higher step counts, particularly in women. Associations of step counts and glycated hemoglobin in this treated diabetes cohort were less definitive and appeared to be mediated by changes in abdominal adiposity.

A 1000 steps/day increment thus appears to be a meaningful step-count dose, with potentially measurable short-term effects in terms of blood pressure changes. With this concept in mind, we now aim to examine step-count prescriptions implemented in routine follow-up of patients with diabetes or hypertension. This strategy will be compared to more general advice about increasing activity levels. Participants will receive a tailored written and verbal step-count prescription from their treating physician and maintain a step-count record that they will review with their doctor. Importantly, the impact of this strategy will be measured in terms of effects on arterial stiffness (i.e. carotid–femoral pulse wave velocity), a summative indicator of vascular health. While blood pressure is an important determinant of arterial stiffness, in the Framingham Heart Study, a 1 SD increment in arterial stiffness was associated with a 48% increase in arterial disease risk, independent of individual vascular risk factors (8). My co-principal investigator Dr. Stella Daskalopoulou (a vascular biologist) is an expert in the noninvasive assessment of vascular health.

A re-engineering of steps into daily life has the potential to build on the stated preference of many diabetes patients for walking as a form of physical activity, as our own focus group studies have indicated (9). Pedometer-based monitoring also captures many other forms of step-related activity, including dancing and stair climbing. Integrating pedometer-based monitoring and target-setting into clinical practice also has the potential to provide the ongoing, long-term support that type 2 diabetes patients indicate they need in order to achieve and maintain higher activity levels. Our trial has the potential to provide Level A evidence to justify the integration of step-count prescriptions into clinical practice.

While we believe the strategy that we propose is potentially effective, its effectiveness could be importantly amplified by socio-environmental changes that enhance the “walkability” of our home and work environments. Neighbourhood walkability is captured by such factors as well-maintained sidewalks, access to public transportation, mixed environments (residential, commercial, service) and safety. Interestingly, in our observational study (conducted in Montreal) the majority of our patients reported their neighbourhoods to be walkable, but nonetheless had low walking levels. A step-count prescription strategy may help patients with diabetes in walkable environments take advantage of their surroundings.

Diabetes management guidelines frequently acknowledge the importance of higher physical activity levels in reducing vascular disease risk, but to date there has been a paucity of evidence-based strategies that may be easily integrated into clinical practice. The development and testing of strategies to increase step counts and optimize other lifestyle behaviours (i.e. smaller food portions, less energy-dense foods, less screen-based entertainment time) needs to be a focus of

research and clinical guideline development if we are to stem further increases in diabetes-related complications. Moving towards a re-engineering of step counts into daily life may indeed be an important first step.

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AUTHOR DISCLOSURES

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POSITION STATEMENT

Use of Glycated Hemoglobin (A1C) in the Diagnosis of Type 2 Diabetes Mellitus in Adults

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The Canadian Diabetes Association (CDA) reviewed the use of glycated hemoglobin (A1C) in the diagnosis of diabetes mellitus. An International Expert Committee, the American Diabetes Association, a joint statement from the American Association of Clinical Endocrinologists/American College of Endocrinology, and a World Health Organization Consultation each recommend an A1C of 6.5% or higher as a criterion for the diagnosis of diabetes (1-4).

The relationship between A1C and retinopathy is similar to that of fasting plasma glucose (FPG) or 2-hour plasma glucose (2hPG) with a threshold at around 6.5% (5-8). Although the diagnosis of diabetes is based on an A1C threshold for developing microvascular disease, A1C is also a continuous cardiovascular risk factor and a better predictor of macrovas-

cular events than FPG or 2hPG (9,10). While many people identified as having diabetes using A1C will not be identified as having diabetes by traditional glucose criteria, and vice versa, there are several advantages to using A1C for diabetes diagnosis (4). A1C can be measured at any time of day and is more convenient than FPG or 2-hour oral glucose tolerance test (OGTT). A1C testing also avoids the problem of day-to-day variability of glucose values, as it reflects the average plasma glucose over the previous 2 to 3 months (2).

In order to use this diagnostic criterion, A1C must be measured using a validated assay standardized to the National Glycohemoglobin Standardization Program—Diabetes Control and Complication Trials reference. It is important to note that A1C may be misleading in individuals with various

Table 1. Factors that can affect A1C (adapted from 11)

Factor	Increased A1C	Decreased A1C	Variable change in A1C
Erythropoiesis	Iron deficiency B12 deficiency Decreased erythropoiesis	Use of erythropoietin, iron or B12 Reticulocytosis Chronic liver disease	
Altered hemoglobin			Fetal hemoglobin Hemoglobinopathies Methemoglobin Genetic determinants
Glycation	Alcoholism Chronic renal failure Decreased erythrocyte pH	Ingestion of aspirin, vitamin C or vitamin E Hemoglobinopathies Increased erythrocyte pH	
Erythrocyte destruction	Increased erythrocyte lifespan: Splenectomy	Decreased erythrocyte lifespan: Chronic renal failure Hemoglobinopathies Splenomegaly Rheumatoid arthritis Antiretrovirals Ribavirin Dapsone	
Assays	Hyperbilirubinemia Carbamylated hemoglobin Alcoholism Large doses of aspirin Chronic opiate use	Hypertriglyceridemia	Hemoglobinopathies

hemoglobinopathies, iron deficiency, hemolytic anemias, and severe hepatic and renal disease (2,3,11) (Table 1). In addition, studies of various ethnicities indicate that African Americans, American Indians, Hispanics and Asians have A1C values up to 0.4% higher than white patients at similar levels of glycemia (12,13). Further research is required to determine if specific ethnic-based A1C cut-points for diabetes diagnosis are warranted. A1C values are also affected by age, rising by up to 0.1% per decade (14-16). More studies may help determine if age-adjusted A1C thresholds are required for diabetes diagnosis in the elderly.

The CDA recommends the addition of A1C as a diagnostic criteria for type 2 diabetes in adults as follows:

1. A1C can be used as a diagnostic test for diabetes using a standardized, validated assay when there are no conditions that preclude its accurate measurement.
2. A1C $\geq 6.5\%$ is one of the diagnostic criteria for diabetes that should be confirmed by repeat testing on a subsequent day.
3. A1C $< 6.5\%$ does not exclude diabetes that may be diagnosed using standard glucose tests (Table 2).
4. Traditional diagnosis using FPG, random glucose with symptoms, or 2hPG during an OGTT are still recommended options for diagnosing diabetes (Table 2).
5. A1C is not recommended for diagnostic purposes in children, adolescents, pregnant women or people with type 1 diabetes.
6. A1C may be misleading and therefore should not be used as a diagnostic tool in the setting of hemoglobinopathies, hemolytic anemia, thalassemias, iron deficiency, spherocytosis, and severe hepatic or renal failure.
7. A1C may be misleading in certain ethnicities and in the elderly, and therefore its utility as a diagnostic tool in these populations is unclear.

The decision as to which test to use for diabetes diagnosis (Table 2) is left to clinical judgment. In the absence of unequivocal hyperglycemia accompanied by acute metabolic decompensation, a repeat confirmatory laboratory test (FPG, casual PG, 2hPG in a 75-g OGTT, A1C) must be done in all cases on another day. It is preferable that the same test be repeated for confirmation. If results of two different tests are available, and both are above the diagnostic cut-points, the diagnosis of diabetes is confirmed. When results of more than one test are available and are discordant, the test with a result above the diagnostic cut-point should be repeated and the diagnosis made on the basis of the repeat test.

The CDA does not recommend specific A1C criteria for the diagnosis of prediabetes. While there is a continuum of risk for diabetes with A1C levels $< 6.5\%$, further research is required to determine whether A1C can be used to identify people at risk for diabetes (currently comprising people with impaired fasting glucose or impaired glucose tolerance).

Table 2. Diagnostic criteria for diabetes (adapted from 17)

<p>FPG ≥ 7.0 mmol/L Fasting = no caloric intake for at least 8 hours or Casual PG ≥ 11.1 mmol/L + symptoms of diabetes Casual = any time of the day, without regard to the interval since the last meal Classic symptoms of diabetes = polyuria, polydipsia and unexplained weight loss or 2hPG in a 75-g OGTT ≥ 11.1 mmol/L or A1C $\geq 6.5\%$ Using a standardized, validated assay, in the absence of conditions that affect the accuracy of the A1C</p>

A repeat confirmatory laboratory test (FPG, casual PG, 2hPG in a 75-g OGTT, or A1C) must be done in all cases on another day in the absence of unequivocal hyperglycemia accompanied by acute metabolic decompensation. It is preferable that the same test be repeated for confirmation. However, in individuals in whom type 1 diabetes is likely (younger or lean or symptomatic hyperglycemia, especially with ketonuria or ketonemia), confirmatory testing should not delay initiation of treatment to avoid rapid deterioration.

2hPG = 2-hour plasma glucose

FPG = fasting plasma glucose

OGTT = oral glucose tolerance test

PG = plasma glucose

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ORIGINAL RESEARCH

Efficacy of A1C Reduction Using Internet Intervention in Patients with Type 2 Diabetes Treated with Insulin

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ABSTRACT

OBJECTIVE: To assess the effect of an Internet-based glucose monitoring system (IBGMS) on glycated hemoglobin (A1C) levels in patients with type 2 diabetes mellitus treated with insulin.

METHODS: Fifty patients were randomly assigned to receive conventional care alone (control) or additional follow-up via IBGMS for 6 months. Patients randomized to the IBGMS group uploaded blood glucose readings to a secure website every 2 weeks to receive feedback from their endocrinologist. After 6 months, all patients returned to conventional care. A1C and laboratory test results were collected at 0, 3, 6 and 12 months.

RESULTS: Baseline parameters were not significantly different. After a 6-month follow-up, A1C dropped from 8.8% to 7.6% ($p < 0.001$) in the IBGMS group vs. the control group, which showed no significant change (8.5% to 8.4%, $p = 0.51$). Both groups then returned to conventional care, and after 12 months, the A1C differences in the IBGMS and control groups were not sustained (8.2% vs. 8.5%, $p = 0.35$).

CONCLUSION: IBGMS significantly improved A1C levels in patients with type 2 diabetes treated with insulin, but this effect was lost with cessation of the intervention.

KEYWORDS: Internet-based blood glucose monitoring, remote monitoring, type 2 diabetes

RÉSUMÉ

OBJECTIF : Évaluer l'effet d'un système de surveillance de la glycémie par Internet (SSGPI) sur les taux d'hémoglobine glycosylée (HbA_{1c}) chez des patients insulinotraités atteints de diabète de type 2.

MÉTHODES : Cinquante patients ont été répartis au hasard

pour recevoir les soins classiques seuls (groupe témoin) ou en association au SSGPI pendant six mois. Les patients du groupe SSGPI ont téléchargé leurs glycémies vers un site Web sécurisé toutes les deux semaines et reçu des commentaires de leur endocrinologue. Après six mois, les patients de ce groupe ont cessé d'utiliser le SSGPI. Les taux d'HbA_{1c} et d'autres paramètres de laboratoire ont été déterminés au départ et après trois, six et douze mois.

RÉSULTATS : Il n'y avait pas de différences significatives entre les groupes pour ce qui est des paramètres initiaux. Après six mois, le taux d'HbA_{1c} avait baissé : il était de 7,6 % (par rapport à 8,8 % au départ; $p < 0,001$) dans le groupe SSGPI et de 8,4 % (par rapport à 8,5 % au départ; $p = 0,51$) dans le groupe témoin. L'utilisation du SSGPI a été abandonnée et, après douze mois, il n'y avait plus de différence entre le groupe SSGPI et le groupe témoin pour ce qui est du taux d'HbA_{1c} (8,2 % et 8,5 %; $p = 0,35$).

CONCLUSION : Le SSGPI a significativement amélioré les taux d'HbA_{1c} chez les patients insulinotraités atteints de diabète de type 2, mais cet effet a disparu après la fin de l'intervention.

MOTS CLÉS : surveillance de la glycémie par Internet, surveillance à distance, diabète de type 2

INTRODUCTION

In the management of diabetes mellitus, self-monitoring of blood glucose (SMBG) is performed as an adjunct to glycated hemoglobin (A1C) measurements in order to assess and modify treatment (1-3); however, it often requires healthcare professionals to help interpret these results to refine treatment (4-6). The Internet provides a readily accessible platform for communication and remote health monitoring (7). In this study, we evaluated whether the use of an Internet-based glucose monitoring system (IBGMS)

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would improve the outcome of care for patients with type 2 diabetes compared to conventional care alone.

METHODS

We enrolled 50 patients with type 2 diabetes treated with insulin, either alone or in combination with oral antihyperglycemic agents. Inclusion criteria included a recent A1C >7.0%, Internet access and prior training in SMBG. Patients were randomly assigned to IBGMS or a control group for 6 months using a computer random number generator. All patients were provided with a blood glucose meter and test strips for testing at least 3-times daily, and were asked to perform a laboratory blood test and visit their endocrinologist at 3 and 6 months. All patients met with the same endocrinologist and were provided with standard office-based care.

Patients randomized to the control group were asked to keep a diary of SMBG to bring to their endocrinologist. Patients randomized to the IBGMS group were asked to upload their SMBG readings every 2 weeks to a secure, commercially available website (ALR Technologies Inc, Atlanta, Georgia). The preliminary results of this intervention are documented elsewhere (8), and more details of the web-based care can be found at www.alrt.com. Data were presented in table and graph formats according to time of day, and automatic calculations were done to show the mean, standard deviation and range for specific time periods. The system allowed patients to input medications, set alarms, view summaries of readings and contact their endocrinologist, who viewed the readings and sent feedback through the ALR messaging system. Patients randomized to the control group were given the option of calling the endocrinologist when they needed assistance. Neither group was taught how to interpret SMBG results, although as part of the inclusion criteria, all patients had completed prior training in SMBG. The endocrinologist's recommendations included changes in insulin dosage, suggestions on testing frequency or giving compliments. A1C values were measured in both groups at 0, 3, 6 and 12 months.

Baseline demographic data were collected from patient charts. A1C values were measured using the ADVIA Centaur Immunoassay System (Siemens, Tarrytown, New York). Data were analyzed using a computer database (Excel, Microsoft Inc., Redmond, Washington) and SAS statistical software (SAS Institute Inc., Cary, North Carolina). Paired sample and independent Student's t-tests were used to compare within- and between-group changes, respectively. The primary outcome was difference in A1C between the IBGMS and control groups at 12 months. Differences between A1C levels were evaluated by performing analysis of covariance that tested between-group changes from the start to the end of the study while adjusting for baseline values. Analysis of variance was performed to see whether changes in A1C

correlated with upload compliance on the IBGMS. For all analyses, statistical significance was established at $p < 0.05$.

RESULTS

Key demographic and baseline clinical characteristics are summarized in Table 1. Four patients (2 from each group) were excluded because they were nonadherent. Differences between the 2 groups at 6 months post-intervention was statistically significant only for A1C (8).

The IBGMS group showed a statistically significant decrease in A1C from baseline ($8.8 \pm 1.3\%$) to 3 months ($8.2 \pm 0.9\%$, $p = 0.053$) and 6 months ($7.6 \pm 0.8\%$, $p < 0.001$). The control group, on the other hand, had A1C levels that were statistically equivalent (Table 2). The baseline A1C-adjusted differences in 6 month A1C were -1.3% and -0.1% for the IBGMS and control groups, respectively ($p < 0.05$). However, 6 months after both groups had returned to conventional care (12 months from baseline), A1C in the IBGMS group returned to baseline levels

Table 1. Demographic and baseline clinical characteristics of the study population

Characteristic	IBGMS (n=23)*	Control (n=23)*	p value
Age, y	57±10	62±7.2	0.097
Male/female, n	14/9	15/8	
Duration of diabetes, y	19.1±9.4	18.8±6.4	0.898
BMI, kg/m ²	33.6±6.5	33.1±6.0	0.799
A1C, %	8.8±1.3	8.5±1.2	0.420

Unless otherwise indicated, data are shown as mean±SD

*Two subjects in the control and IBGMS groups did not follow protocol and were excluded

A1C = glycated hemoglobin

BMI = body mass index

IBGMS = Internet-based glucose monitoring system

Table 2. Changes in A1C for control vs. IBGMS groups

	IBGMS A1C, % (n=23)	Control A1C, % (n=23)	p value
Start	8.8±1.3	8.5±1.2	0.42
3 months	8.2±0.9	8.3±1.1	0.60
6 months	7.6±0.8 [†]	8.4±1.4	<0.05*
12 months	8.2±1.0 [‡]	8.5±1.3	0.35

Unless otherwise indicated, data are shown as mean±SD

*Statistically significant, IBGMS vs. control; analysis adjusted for baseline A1C

[†]Statistically significant vs. A1C at start and 3 months ($p < 0.001$)

[‡]Statistically significant vs. A1C at 6 months ($p < 0.05$), but not vs. start ($p = 0.055$)

A1C = glycated hemoglobin

IBGMS = Internet-based glucose monitoring system

NA = not applicable

($8.2 \pm 1.0\%$, $p=0.055$) and were no different from those of the control group ($8.5 \pm 1.3\%$, $p=0.35$).

The IBGMS group had the option to upload their data 12-times within the 6-month period. On average, patients in the IBGMS group uploaded 71.9% (range 28%–94%) of the time, with an average of 9.4 uploads. The percentage of uploads on the IBGMS was not correlated with change in A1C ($p=0.51$) after 6 months. Two patients from the IBGMS group were excluded from the above analyses because they were nonadherent.

DISCUSSION

Patients with diabetes treated with insulin are often concerned about the risk of hypoglycemia and/or hyperglycemia. To avoid these situations, frequent SMBG testing is required. However, a significant number of patients require communication with their physician to interpret these results and modify insulin dosage to achieve glucose targets. We used and tested an IBGMS to test whether communication over the Internet was sufficient enough to improve glycemic control.

In our study, patients randomized to the IBGMS group had significant A1C improvement after 6 months. Both study groups were provided with resources for testing blood glucose levels and met with an endocrinologist at 3 and 6 months. The only difference was that the IBGMS group was asked to upload their blood glucose levels onto an Internet platform. Almost all study patients in the IBGMS group, except 2 who were nonadherent and excluded from analysis, uploaded their data regularly, as they were frequently reminded to test and upload their data through the ALR messaging system. This ongoing communication allowed the endocrinologist to recommend changes in insulin dosage and regimen, and/or patterns of testing as needed to direct redistribution of the insulin regimen. At 12 months, both groups returned to pre-study A1C levels after resuming conventional care for 6 months. Our results demonstrate that the improvement during the study was not sustained after discontinuation of the IBGMS intervention, indicating that constant communication is required for optimal care. It should be noted that all patients attend a comprehensive 4-day education course when diagnosed with diabetes. As such, they have already been taught blood glucose goals and insulin adjustment. Despite this standardized education, further improvement was seen in the IBGMS group. This improvement reversed to baseline when the intervention was withdrawn.

There are several limitations to this study. We monitored only glycemic control, and thus some factors that were not measured may have confounded the results. In the 6 months of conventional care following IBGMS, we did not monitor the number of blood glucose tests being used and

did not supply patients with test strips. Therefore, changes in A1C levels could result from a lower number of SMBG tests performed by the IBGMS group. However, the control group did not have access to these resources either, and their A1C levels stayed the same. Furthermore, all patients were testing regularly, because they were administering insulin and were seen by an endocrinologist within 3 to 6 months. The period of conventional care also mimics the real world, where patients are seen every 3 or 6 months, with no recurrent follow-ups in between.

The advantages of using an IBGMS include automatic uploading, eliminating the need for patients to keep a written diary. In addition, the uploaded data can be analyzed and displayed in table and graph formats, giving a sense of glucose trends and monitoring frequency. This can save time for the physician and increase the accuracy of data interpretation (9). Limitations of the system include patient's unwillingness or lack of desire to use the Internet and the absence of a payment model to reimburse out-of-office consultations.

Previously published studies have also shown improvements in A1C levels in patients with type 2 diabetes who used an IBGMS system compared to controls (10–12). However, these studies involved nurses, dietitians or an electronic medical records system, while our study was limited to the patient's endocrinologist monitoring and making recommendations based on an IBGMS. While this was not a substitute for the patient–physician interaction in a clinical setting; however, it significantly improved A1C and, over time, we observed better glycemic control and patient satisfaction. This method of follow-up can reduce the inconvenience of booking appointments solely for giving recommendations on changes in insulin dosage and may be a more cost-effective method of follow-up, especially for rural patients where access to a diabetes specialist is limited. In summary, the continuous use of an IBGMS is an effective method of improving glucose control compared to standard care.

AUTHOR DISCLOSURES

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AUTHOR CONTRIBUTIONS

HT designed the study; developed the protocol; collected and interpreted data; and wrote, reviewed and edited the manuscript. AM contributed to protocol development; collected, analyzed and interpreted data; and wrote, reviewed and edited the manuscript. JC analyzed and interpreted

data; and wrote, reviewed and edited the manuscript. SR contributed to the study design and protocol development; interpreted data; and reviewed and edited the manuscript. All authors read and approved the final manuscript.

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ORIGINAL RESEARCH

Body Mass Index and Food and Nutrient Intake of Children with Type 1 Diabetes and a Carbohydrate Counting Meal Plan

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ABSTRACT

OBJECTIVE: To document body mass index and food intake in relation to level of carbohydrate counting in children with type 1 diabetes.

METHODS: Weight, height, glycated hemoglobin and two 24-hour dietary recalls were recorded in 70 children with type 1 diabetes (age 6 to 12 years) on intensive insulin therapy, with a meal plan based on basic (n=21) or advanced (n=49) carbohydrate counting.

RESULTS: The distribution of weight status (not overweight, overweight, obese) was similar in both meal plan groups, and the overall prevalence of overweight (15.7%) and obesity (5.7%) was similar to that of the general Quebec youth population. Mean intake of fibre and potassium was lower than adequate intake, regardless of sex and age. Vitamin C was the nutrient with the highest prevalence of inadequate intake. Children using advanced carbohydrate counting drank less milk ($p < 0.03$) and tended to have lower vitamin D intake ($p < 0.06$) than children using basic carbohydrate counting, but no other differences were detected in food, energy or nutrient intake. Added sugar represented $< 10\%$ of total energy intake in both the basic and advanced groups.

CONCLUSION: Meal plans based on carbohydrate counting do not appear to expose school-aged children with type 1 diabetes to a greater risk of obesity or overweight. Contrary to what is sometimes assumed, advanced carbohydrate counting did not lead to higher energy or sugar intake in this sample. Although their diet is similar to that of children without diabetes, children with type 1 diabetes should receive education about adequate food choices to increase their intake of fibre and micronutrients.

KEYWORDS: body mass index, carbohydrate counting, children, food intake, type 1 diabetes

RÉSUMÉ

OBJECTIF : Établir le lien entre l'indice de masse corporelle et l'apport alimentaire, d'une part, et la méthode de calcul des glucides, d'autre part, chez des enfants atteints de diabète de type 1.

MÉTHODES : On a mesuré le poids, la taille et l'hémoglobine glycosylée et demandé aux enfants ce qu'ils avaient mangé pendant deux périodes de 24 heures. L'étude a été menée auprès de 70 enfants atteints de diabète de type 1 (de 6 à 12 ans) recevant une insulinothérapie intensive et dont le plan de repas était fondé sur un calcul des glucides de base (n = 21) ou avancé (n = 49).

RÉSULTATS : La distribution de statut de poids (pas de surpoids, surpoids, obésité) était semblable dans les deux groupes de plan de repas et la prévalence globale du surpoids (15,7 %) et de l'obésité (5,7 %) était semblable à celle observée chez les jeunes dans la population générale du Québec. La consommation moyenne de fibre et de potassium était insuffisante, indépendamment de l'âge et du sexe. La vitamine C était le nutriment pour lequel l'apport était le plus souvent insuffisant. Les enfants qui utilisaient le calcul avancé des glucides buvaient moins de lait ($p < 0,03$) et avaient tendance à consommer moins de vitamine D ($p < 0,06$) que les enfants qui utilisaient le calcul de base des glucides, mais aucune autre différence n'a été observée pour ce qui est de l'apport en aliments, en énergie et en nutriments. Le sucre ajouté constituait $< 10\%$ de l'apport énergétique total tant dans le groupe utilisant la méthode de base que dans celui utilisant la méthode avancée.

CONCLUSION : Les plans de repas fondés sur le calcul des glucides ne semblent pas augmenter le risque de surpoids ou d'obésité chez les enfants d'âge scolaire atteints de diabète de type 1. Contrairement à ce qu'on suppose parfois, le calcul avancé des glucides n'a pas entraîné d'augmentation

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de l'apport en énergie ni en sucre. Les enfants atteints de diabète de type 1 ont une alimentation semblable à celle des autres enfants, mais il faut leur apprendre à faire de bons choix alimentaires pour augmenter leur consommation de fibre et d'oligoéléments.

MOTS CLÉS : indice de masse corporelle, calcul des glucides, enfants, apport alimentaire, diabète de type 1

INTRODUCTION

Along with insulin and self-monitoring of blood glucose, meal planning is a cornerstone of the management of type 1 diabetes mellitus in children and adolescents (1), although it is often considered to be one of the most difficult aspects of treatment (2). In addition to supplying an adequate intake of nutrients, the goals of nutrition therapy in children with type 1 diabetes are to maintain blood glucose levels close to normal in order to prevent or delay vascular complications; to reduce the risk of severe hypoglycemia; and to avoid excess weight gain while promoting optimal growth (3).

Currently, many children with type 1 diabetes are treated with multiple daily insulin injections or continuous subcutaneous insulin infusion, with nutrition therapy consisting of either basic or advanced carbohydrate counting (2). Carbohydrate counting is a meal planning method that focuses on carbohydrate as the primary nutrient affecting postprandial blood glucose response. Patients aiming for blood glucose control while maintaining flexibility in food choices for meals and snacks are candidates for this approach. Using basic carbohydrate counting, patients with diabetes learn to estimate the carbohydrate content of foods and work to keep their carbohydrate intake consistent from day to day, according to their meal plan. Advanced-level carbohydrate counting is for individuals who can learn to match their preprandial insulin to their carbohydrate intake using individualized insulin-to-carbohydrate ratios (4-6).

Recently, concerns have been raised about possible dietary overconsumption and/or poor-quality intakes in children with diabetes who use carbohydrate counting (7-9). While some studies have reported the overall food and nutrient intake of youth with type 1 diabetes (8,10-15), none has documented body mass index (BMI) or the quality and quantity of food intake in relation to basic or advanced carbohydrate counting—the purpose of this work.

METHODS

Participants

Families of 70 children with type 1 diabetes on intensive insulin therapy were recruited at the pediatric diabetes clinic of the Centre Mère-Enfant at Laval University Hospital Centre (CHUL). Inclusion criteria were as follows: age 6 to 12, diagnosed with type 1 diabetes for at least 1 year,

following a meal plan based on carbohydrate counting for at least 3 months (basic or advanced), no food allergies or lactose intolerance, and no diagnosis of other chronic diseases. Study approval was received from the CHUL Ethics Committee for Clinical Research.

General questionnaire

When families agreed to enter the study, a written questionnaire was first administered to one of the parents by a trained nutrition student (VB). Questions included the child's date of birth, date of diagnosis of type 1 diabetes, current meal and snack schedule, and usual appetite and physical activity. Current basal and total insulin doses were recorded, as well as the insulin regimen. In addition, parents were asked to indicate how long their child had been on a carbohydrate counting meal plan and, for those at the advanced level, the insulin-to-carbohydrate ratio used for each meal.

Anthropometric and biochemical measurements

Weight, height and glycated hemoglobin (A1C) were recorded in all children on the day of recruitment, during their diabetes clinic visit. BMI (kg/m^2) was also calculated, and the prevalence of overweight and obesity in the sample was assessed using international BMI cutoff points for children (16).

24-hour dietary recalls

The food intake of participating children was collected using two 24-hour dietary recalls. The first dietary recall was completed with the parent and child during the clinic visit, and the second was done over the telephone within the following 2 weeks. Three families did not complete the second recall; food data for their children were excluded from the nutrition and dietary analyses.

Nutritional analyses/dietary assessment

Food recalls were analyzed for nutrient intake using the Nutrific nutrition software developed at Laval University (Quebec, Quebec) based on the Canadian Nutrient File (17). Mean daily intakes of energy, macronutrients and micronutrients were calculated for each child. Mean group intakes were also calculated and compared to dietary reference intakes (DRIs) for sex and age (18). For energy, mean group intakes were compared to the range of estimated energy requirement for the "low active" to "active" levels of physical activity (19). For macronutrients, acceptable macronutrient distribution ranges (AMDRs) were used and mean group intakes were compared to recommended intakes for nutrients that had an adequate intake (AI) as a DRI, including calcium and vitamin D (which were in this category at the time of the study). For micronutrients that had a recommended daily allowance as a DRI, the prevalence

of inadequate intake was assessed using the estimated average requirement (EAR) cutoff method (19).

Analysis of food intake was also performed based on the 24-hour dietary recalls. For each recall, all foods and drinks were converted into number of food group servings from the *Meal Planning for People with Diabetes* guide (20): starches; fruits; vegetables; milk and alternatives; foods with added sugar; meat and alternatives; fats; and low-calorie foods. To further characterize beverage intake, subgroups were created in milk and alternatives (total liquid milk, 2% milk), fruits (pure fruit juice), foods with added sugars (regular soda) and low-calorie foods (diet soda). A light fruit beverage group was also created, with 1 serving corresponding to 125 mL of carbohydrate-reduced (but not hypocaloric) fruit drink. For each child, the daily number of servings in each food group and subgroup were calculated as the average of both 24-hour food recalls.

Statistical analyses

All analyses were performed using SAS-PC version 9.1 (SAS Institute Inc., Cary, North Carolina). The chi-square test of significance was used to assess differences in frequency distributions. Student's unpaired t-test was used to compare means according to the level of application of carbohydrate counting (basic vs. advanced). The level of significance was set at $p=0.05$.

RESULTS

Characteristics of subjects

The mean age \pm SD of the 70 children was 9.7 \pm 1.9 years, and the mean duration of diabetes was 5.7 \pm 2.7 years. Mean height, weight and BMI were 137.3 \pm 14.2 cm, 35.6 \pm 11.0 kg and 18.5 \pm 2.6 kg/m², respectively. The mean A1C was 8.1 \pm 0.7%. The mean total dose of insulin was 30.9 \pm 13.1 U/d, or 0.85 \pm 0.22 U/kg/d. The study sample was comprised of more boys than girls, and most subjects were treated with multiple daily insulin injections (Table 1). More than two-thirds were using advanced carbohydrate counting.

Prevalence of overweight

Among the 70 children, 4 were obese and 11 were overweight. These proportions were not significantly affected by level of carbohydrate counting (Figure 1) or by sex (results not shown).

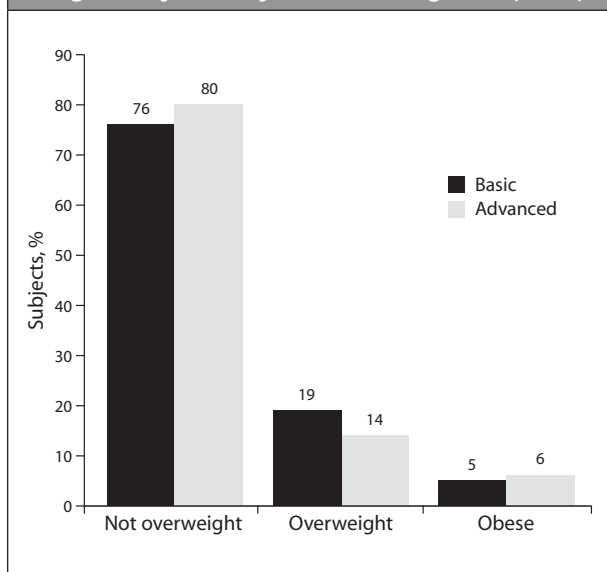
Energy, macronutrient and micronutrient intake according to sex and age

Daily intakes according to sex and age are presented in Table 2. All groups generally met the recommended ranges, even though energy intake was slightly high in 6- to 8-year-old boys. The DRI recommendation for cholesterol is to keep intake as low as possible. In boys, the average daily intake

Table 1. Description of participants (n=70)

Characteristic	Frequency	% responses
Sex		
Male	39	55.7
Female	31	44.3
Insulin regimen		
Multiple daily injections	42	60.0
Continuous subcutaneous infusion	28	40.0
Daily physical activity		
<1	22	31.4
≥ 1	48	68.6
Usual appetite		
Less than other children of his/her age	7	10.0
Equal to other children of his/her age	41	58.6
More than other children of his/her age	22	31.4
Carbohydrate counting meal plan		
Basic	21	30.0
Advanced	49	70.0

Figure 1. Distribution of children in weight categories by carbohydrate counting level (n=70)



$\chi^2=0.153$ (NS)

was approximately 200 mg; in girls, it was lower in the 6- to 8-year-old group and higher in the 9- to 12-year-old group. The average daily intake of dietary fibre was approximately 15 g, far below the AI for all groups.

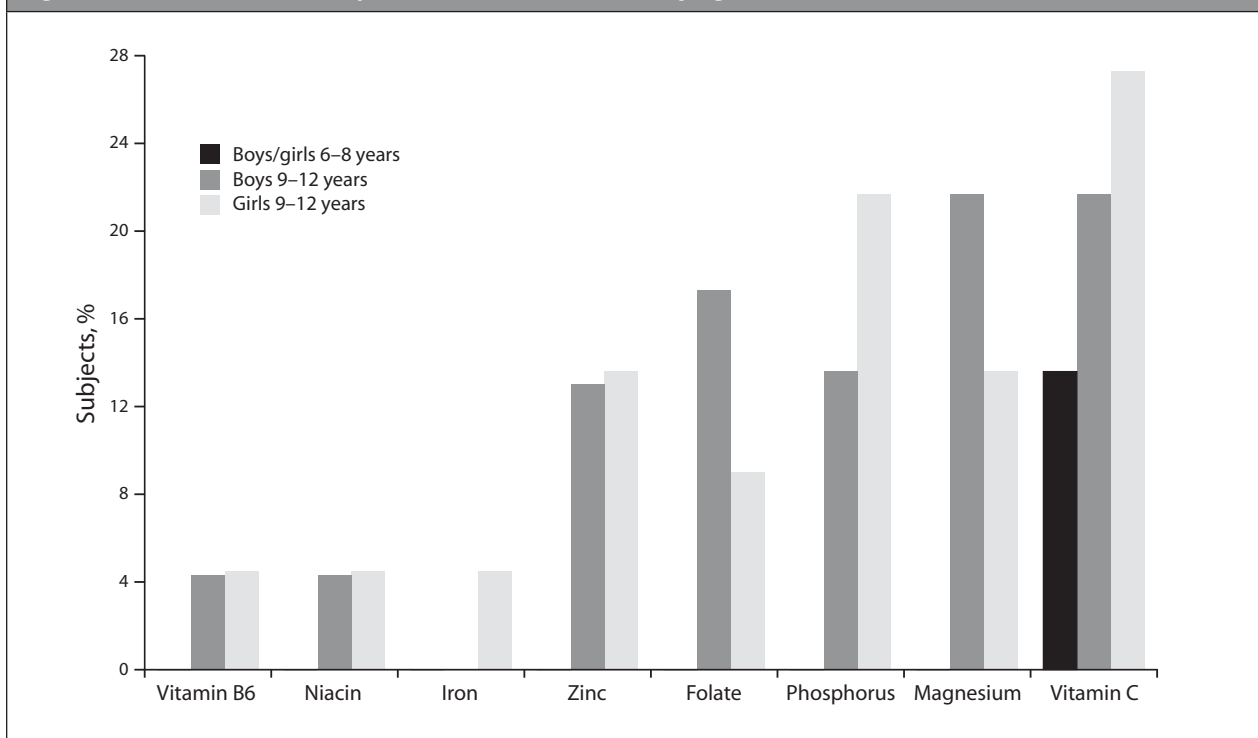
Mean calcium intake exceeded AI in all groups except 9- to 12-year-old girls. Mean vitamin D intake was greater than AI (5 μ g) in all groups, but generally lower in girls than in boys. Interestingly, 9- to 12-year-old girls had a mean energy intake similar to that of 6- to 8-year-old boys, but the calcium and vitamin D intakes of the latter were considerably higher. In all groups, mean intake of potassium was below AI.

The EAR cutoff method demonstrated that the prevalence of inadequate intake varied among age and/or sex

Table 2. Average daily intakes according to sex and age

Nutrient	Boys 6–8 years (n=14)	Girls 6–8 years (n=8)	Boys 9–12 years (n=23)	Girls 9–12 years (n=22)
Kilocalories	1874±372 (1617–1840)	1665±181 (1515–1719)	1910±373 (1875–2149)	1840±346 (1729–1972)
Carbohydrates, % kcal	52.4±5.7 (45–65)	55.0±3.4 (45–65)	52.7±6.5 (45–65)	52.9±6.7 (45–65)
Lipids, % kcal	31.0±4.9 (25–35)	30.5±2.4 (25–35)	32.0±4.5 (25–35)	32.5±5.0 (25–35)
Proteins, % kcal	17.7±3.2 (10–30)	16.3±2.9 (10–30)	17.1±2.7 (10–30)	16.5±3.2 (10–30)
Fibre, g	14.9±5.2 (25)	14.1±3.2 (25)	16.3±6.3 (31)	15.6±6.2 (26)
Cholesterol, mg	202±71	165±66	205±81	221±111
Calcium, mg	1415±339 (800)	1142±339 (800)	1305±404 (1300)	1096±439 (1300)
Potassium, mg	2936±802 (3800)	2344±500 (3800)	3080±922 (4500)	2785±646 (4500)
Vitamin D, µg	8.3±3.0 (5)	5.1±2.7 (5)	7.8±4.1 (5)	5.5±3.4 (5)

Mean±SD (dietary reference intake)

Figure 2. Prevalence of inadequate micronutrient intake by age and sex*

*Estimated average requirement used as cutoff point

groups (Figure 2). Among 6- to 8-year-old boys and girls, inadequate intake was found for only vitamin C, with a prevalence of 13.6%. Among 9- to 12-year-old boys, the prevalence of inadequate intake was 4.3% for vitamin B6 and niacin, 13.0% for zinc and phosphorus, 17.3% for folate, and 21.7% for magnesium and vitamin C. In the 9- to 12-year-old girls group, it was 4.5% for vitamin B6, niacin and iron, 9.0% for folate, 13.6% for zinc and magnesium, 22.7% for phosphorus and 27.3% for vitamin C.

Energy, nutrient and food intake according to carbohydrate counting level

Table 3 demonstrates that energy and macronutrient intakes

were similar in the 2 meal plan groups. For micronutrients, only one significant difference was found: vitamin D intake tended to be lower ($p < 0.06$) in children using advanced-level carbohydrate counting.

Table 4 reports the daily number of food servings from the 24-hour recalls. Among carbohydrate sources, vegetables were the least consumed. Milk and alternatives averaged almost 4 servings per day for children using basic carbohydrate counting and almost 3 servings per day for those using advanced carbohydrate counting ($p < 0.03$). Foods with added sugar also averaged approximately 3 servings per day in both groups. Because 1 serving of food with added sugar contains 15 g of carbohydrate, the average daily

Table 3. Daily energy and nutrient intakes by carbohydrate counting level (n=67)

Nutrient	Carbohydrate counting level		
	Basic (n=18)	Advanced (n=49)	p
Kilocalories	1886±444	1836±310	NS
Carbohydrates, % kcal	53.7±6.2	52.7±6.0	NS
Lipids, % kcal	30.2±4.0	32.3±3.6	NS
Proteins, % kcal	17.4±2.6	16.8±3.1	NS
Fibre, g	15.0±7.1	15.7±5.1	NS
Calcium, mg	1405±542	1179±333	NS
Potassium, mg	3033±911	2804±739	NS
Vitamin D, µg	8.5±4.6	6.2±3.1	0.06
Iron, mg	12.3±4.9	12.3±3.5	NS
Magnesium, mg	271±102	269±69	NS
Phosphorus, mg	1584±554	1421±345	NS
Zinc, mg	10.7±4.2	10.0±2.9	NS
Niacin, mg	17.5±5.4	17.9±5.9	NS
Vitamin B6, mg	1.59±0.55	1.59±0.51	NS
Vitamin C, mg	102±83	106±71	NS

Table 4. Daily number of food servings by carbohydrate counting level (n=67)

Food serving	Carbohydrate counting level		
	Basic (n=18)	Advanced (n=49)	p
Carbohydrate sources			
Starches	6.7±1.8	6.6±1.8	NS
Fruits	2.6±1.9	2.7±1.6	NS
Vegetables	1.6±1.2	1.4±1.1	NS
Milk and alternatives	3.8±1.7	2.7±1.1	0.03
Foods with added sugar	2.9±2.3	2.8±1.5	NS
Protein sources			
Meat and alternatives	4.1±1.8	4.4±2.1	NS
Fat sources			
Fats	6.3±3.3	7.4±2.3	NS
Other			
Low-calorie foods	1.5±1.3	1.7±1.2	NS
Beverages			
Liquid milk*	2.8±1.6	1.8±1.0	0.03
2% milk†	2.3±1.9	1.2±1.3	0.03
Pure fruit juice‡	1.0±1.5	1.0±1.2	NS
Light fruit beverage	0.0±0.0	0.2±0.7	0.07
Diet soda§	0.1±0.3	0.3±0.6	NS

*Subgroup of milk and alternatives

†Subgroup of liquid milk

‡Subgroup of fruits

§Subgroup of low-calorie foods

intake of added sugars was 44 g in the basic group and 42 g in the advanced group, representing 9.3% and 9.2% of total energy, respectively. Low-calorie foods averaged fewer than 2 servings per day, among which diet soda accounted for less than a third of a serving. In both meal plan groups, the most popular beverage was liquid milk, most of which was 2% milk. However, children using basic carbohydrate counting drank more milk (about 1 serving more) than children using advanced counting ($p<0.03$). The least consumed beverage in this sample was regular soda (nil for virtually all children, results not shown).

DISCUSSION

Prevalence of overweight and obesity

Using the same method of classification (16), the distribution of overweight and obesity in this sample of 6- to 12-year-old children with type 1 diabetes was very similar to that of the general Quebec youth population (2 to 17 years) in 2004, in which 7.1% of children were obese, 15.5% were overweight and 77.4% were not overweight (21). It is generally thought that children with diabetes are heavier than their peers without diabetes (22); however, Papadaki and colleagues found no difference in weight or BMI between children and adolescents (6 to 17 years) with type 1 diabetes and sex- and age-matched controls (23). Helgeson and colleagues reported that 10- to 14-year-old American adolescents with type 1 diabetes had higher BMIs than those without diabetes, although similar percentages of adolescents with and without diabetes exceeded the 95th percentile of BMI for age (11). In a Canadian study conducted in Alberta, Sandhu and colleagues (24) calculated the prevalence of overweight (BMI for age from 85th to 95th percentile) and obesity (BMI >95th percentile) in children with and without type 1 diabetes and aged 6 to 16 years. Greater rates of overweight (but not obesity) were found for children with type 1 diabetes across all age groups and in both sexes. Using the same method, Liu and colleagues calculated the prevalence of overweight and obesity in a population-based study of racially and ethnically diverse youth (3 to 19 years) with and without diabetes in the United States (25). They found that the prevalence of overweight was higher in youth with type 1 diabetes compared to youth without diabetes, but among non-Hispanic whites, the prevalence of obesity was 10.7% for youth with type 1 diabetes and 15.8% for youth without diabetes. Hence, the assumption that children with type 1 diabetes are more prone to obesity than children without diabetes does not appear to be confirmed in all studies.

In addition to overinsulinization or excess energy intake, insufficient physical activity could be a major contributing factor to overweight or obesity in children with type 1 diabetes. In this study, data were not conclusive, as parents

were asked only about the number of hours per week their child generally spent on sports, exercise or other physical activity. Overall, 68.6% spent >1 hour/day engaged in physical activity, less than the 74.1% reported for the 6-to-11 age group in the general Quebec population (21). More in-depth examination of physical activity in children with type 1 diabetes would be valuable.

Quality of nutrient intake

A recent review used the results of 9 observational studies (6 from the United States, 3 from Europe) to document usual dietary intakes in youth with type 1 diabetes (8). Ages of participants varied from 2 to 8 years (26) to 13 to 19 years (12). Although dietary assessment methods differed among studies, consistent findings were that fruit, vegetable and fibre intakes were low (8). Regarding macronutrients, 3 recent studies with control groups reported that children with type 1 diabetes consumed more total fat and saturated fat and fewer carbohydrates than children without diabetes (11,13,27), whereas Papadaki and colleagues (23) found no difference and Virtanen and colleagues observed the opposite (28).

Because there is no research describing the nutrient requirements for children and adolescents with diabetes, nutrient recommendations are based on requirements for all youth (2). Hence, in the present work, average intakes were compared to DRIs according to sex and age group (18,19). While the distribution of energy among macronutrients was in line with the AMDR, we observed a low daily fibre intake, in accordance with studies cited above. This was also reported for the general Quebec youth population, in which the median daily intake of fibre in 2004 was 13.5 g for 4- to 8-year-old boys and girls; 16 g for 9- to 13-year-old boys; and 14.4 g for 9- to 13-year-old girls (21). Also similar to the general youth population were intakes of vitamin D (near the AI) and potassium (clearly below the AI) in all sex and age groups; nil or almost nil prevalence of inadequate intake for thiamine, niacin, riboflavin and vitamins B6 and B12; and similar prevalence of inadequate intake for phosphorus, magnesium and zinc (generally higher among 9- to 13-year-old girls than among 9- to 13-year-old boys or 4- to 8-year-old boys and girls) (21).

However, a noticeable difference was found for vitamin C: while its prevalence of low intake was nil in the general 4- to 13-year-old Quebec population, it was above 20% in children with type 1 diabetes in this study. Vegetables and fruits are the major sources of vitamin C in the diet of 4- to 13-year-old children, but other foods (among them fruit beverages) are also a significant contributor, up to 20% of total intake (21). In this study, the average daily intake of vegetables (excluding starchy vegetables) and fruits was approximately 4 servings per day, which is quite low. It was also noted that the average intake of pure fruit juice was

approximately 1 serving, or 125 mL. It can be hypothesized that because they are less concerned with the carbohydrate content of these products, children without diabetes drink larger quantities of fruit juices and fruit beverages, thus meeting their vitamin C requirement more readily.

In this work, even though 9- to 12-year-old girls had an average energy intake similar to that of 6- to 8-year-old boys, their intake of micronutrients was often lower. As food patterns are not expected to improve when girls reach adolescence, these early discrepancies may be of some concern. In addition, it was reported that 10% of adolescent girls with type 1 diabetes meet criteria for eating disorders, compared to 4% of their age-matched peers without diabetes (29). Vigilance on nutritional issues is thus especially important for girls with type 1 diabetes reaching adolescence.

Nutrient and food intake according to carbohydrate counting level

It is now generally agreed that carbohydrate counting can be a suitable meal planning option in pediatric diabetes, but controversy remains. While some authors advocate the flexibility and simplicity of this approach (6,30), others have expressed concerns that using insulin-to-carbohydrate ratios (i.e. advanced level) may affect diet quality (8). In the present work, we compared the food and nutrient intake of children with type 1 diabetes according to carbohydrate counting level. To our knowledge, no other study has reported such a comparison.

There were no significant differences in energy, macronutrient or micronutrient intakes between the basic and advanced groups, although a strong tendency for lower intake of vitamin D in children using advanced carbohydrate counting was noted. In accordance with this observation, their intake of foods from the milk and alternatives group, especially 2% liquid milk, was also significantly lower. However, children using advanced carbohydrate counting still consumed an average of almost 3 servings per day, in line with food recommendations for their age group. The higher intake of milk and alternatives in children using basic carbohydrate counting might be due to the fact that when they are first taught the approach, children with diabetes (or their parents, in the case of young children) are often advised not only to be consistent from day to day in terms of carbohydrate intake, but also to include a certain number of daily carbohydrate servings (or "carbohydrate choices") in their diet, using a food serving guide as a learning tool (6,31). For school-age children, it is often recommended that a serving of milk be included with each meal, as well as with the bedtime snack and, in fact, children using basic carbohydrate counting in this study consumed almost exactly 4 servings of milk and alternatives per day.

Interestingly, no difference was found in food intake

of foods with added sugars, which averaged about 3 servings per day in both groups. The recommendation to limit sucrose intake to <10% of total energy intake (22) was apparently met.

Study limitations

This was an observational study, and therefore we had no control over the distribution of children between the basic and advanced level of carbohydrate counting. The lower proportion of subjects using the basic level, coupled with a relatively small sample size, may have affected the statistical power to detect differences between levels of application.

Although a single 24-hour dietary recall is a valid method to study food and nutrient intake in groups (19), and 2 recalls were collected in this study, a larger number of recalls could have yielded a better estimation of usual food intake.

This work was conducted in 6- to 12-year-old children who rely primarily on their parents for food purchase and meal planning. It would have been of great interest to include adolescents with type 1 diabetes in the sample and to verify if results would be different in this age group.

CONCLUSION

In conclusion, flexible meal planning approaches centred on carbohydrate counting do not seem to lead to energy or sugar overconsumption in school-aged children with type 1 diabetes, or to expose them to a greater risk of obesity or overweight. However, attention should be paid to promoting adequate food choices to increase intake of fibre and potassium, and more emphasis on vitamin B6, vitamin C, vitamin D, iron, magnesium, niacin, phosphorus and zinc intakes, especially in the 9- to 12-year-old group. To do so, intake of meat and substitutes, vegetables and fruits, whole grain cereals and milk, and alternatives should be encouraged.

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AUTHOR DISCLOSURES

No dualities of interest declared.

AUTHOR CONTRIBUTIONS

VB was responsible for the data collection, review and analysis, and drafting the manuscript. IB contributed substantially to the conception and study design, acquisition of data, and critically revised the manuscript. IG was responsible for the conception and study design, supervision of VB, data interpretation, and manuscript revision and editing.

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ORIGINAL RESEARCH

Primary Care Physician Referral Patterns to Diabetes Education Programs in Southern Ontario, Canada

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ABSTRACT

OBJECTIVES: Despite the reported benefits of diabetes self-management education (DSME), participation rates are low across North America. This study examines primary care physician (PCP) referral practices to diabetes education programs (DEPs) and factors that influence referral in a large suburban region in Ontario, Canada.

METHODS: Ninety-nine PCPs practicing in the Peel and Halton regions of Ontario were sampled from the Ontario Medical Association membership list, and completed questionnaires were submitted online or by fax. Frequencies were tabulated for all responses.

RESULTS: Fewer than half of PCPs referred all of their diabetes patients to DEPs. Common reasons for not referring were patients' unwillingness to attend, lack of evening/weekend appointments, language barriers, long referral waiting lists and inconvenient location for patients.

CONCLUSION: Fewer than half of PCPs surveyed followed the Canadian Diabetes Association recommendation to refer patients to DSME. Physician referral was found to be encumbered by patient, system and operational factors. DEPs need to tailor their programming to meet the needs of their community and to commit to more outreach services to increase PCP and patient access as well as awareness of DSME services.

KEYWORDS: diabetes, education, primary care physicians, referral practices, self-management

RÉSUMÉ

OBJECTIFS : Malgré les avantages de l'éducation sur l'autogestion du diabète (EAGD), les taux de participation

sont faibles partout en Amérique du Nord. La présente étude porte sur les pratiques des médecins de premier recours (MPR) en matière d'orientation vers les programmes d'éducation sur le diabète (PED) et sur les facteurs qui influent sur l'orientation vers ces programmes dans une grande banlieue de l'Ontario, au Canada.

MÉTHODES : Quatre-vingt-dix-neuf MPR des régions de Peel et Halton (Ontario) qui avaient été choisis à partir de la liste des membres de l'Ontario Medical Association ont rempli des questionnaires à retourner en ligne ou par télécopieur. Les fréquences ont été calculées pour toutes les réponses.

RÉSULTATS : Moins de la moitié des MPR orientaient tous leurs patients diabétiques vers des PED. Les raisons courantes de la non-orientation vers des PED étaient les suivantes : réticence des patients à participer, manque de programmes offerts le soir ou la fin de semaine, barrière linguistique, longues listes d'attente et lieux peu commodes pour les patients.

CONCLUSION : Moins de la moitié des MPR interrogés orientaient les patients vers l'EAGD, comme le recommande l'Association canadienne du diabète. On a constaté que des facteurs liés aux patients et au système et des facteurs opérationnels empêchaient les médecins d'orienter les patients vers l'EAGD. Les responsables des PED doivent adapter les programmes aux besoins des communautés visées et offrir davantage de services d'approche pour accroître l'accès et la sensibilisation des MPR et des patients aux services d'EAGD.

MOTS CLÉS : diabète, éducation, médecins de premier recours, pratiques d'orientation, autogestion

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INTRODUCTION

Diabetes is a chronic disease that requires a lifelong commitment to complex lifestyle modifications involving patient adherence to oral medications, insulin therapy, nutrition management, regular blood glucose monitoring and physical activity (1), all of which have been shown to reduce both the risk and progression of diabetes-related complications (2-4). However, achieving and sustaining effective disease management can be challenging. Individuals with diabetes must become experts in the management of their illness, often requiring external sources of support to provide aid and education with respect to engaging in self-care behaviours.

Primary care physicians (PCPs) understand the importance of providing patient support for chronic disease management, but are often unable to deliver the education and lifestyle-modification strategies necessary to manage patients' chronic illnesses (5-8). They face numerous barriers, such as increased demands on their time (9) and lack of knowledge and expertise to properly support and manage patients (10). As a result, structured diabetes self-management education (DSME), which is typically delivered by diabetes education programs (DEPs), is now recommended as a critical resource to support patients. DSME has been proven to enhance self-care behaviours (11-15), which can delay or prevent the development of health complications, lower healthcare costs (16,17) and improve quality of life (11,14). There is no doubt that DSME should be incorporated into diabetes care plans to help patients effectively manage this disease.

However, despite the benefits of DSME, only one-third of individuals with diabetes attend DEPs in Canada (18,19); a similar proportion is reported in the United States (US) (20-22). This suggests that Canadians with diabetes are not receiving the multidisciplinary care they need to effectively manage their disease and prevent further complications. PCPs highly influence DSME utilization because they are typically the first point of contact for patients in the healthcare system, are usually diagnosing diabetes and are gatekeepers to diabetes-related resources (23). Moreover, most patients report PCPs as their main source of diabetes information (24) and referral to DEPs (25,26).

It is apparent that PCPs' evaluation of patient needs greatly influence patients' utilization of services and resources, making PCPs' attitudes about DEPs as important as those of their patients when it comes to influencing participation (27). However, PCP referrals to DEPs in North America are disproportionately low; for instance, 1 national Canadian study found that 52% of physicians would refer patients with diabetes to a DEP in a hypothetical situation (5), while another study based on census and healthcare data in Calgary, Alberta, reported a referral rate of 14% (28). A

referral rate of 45% to external DEPs (not including education services provided by educators onsite) was estimated for physicians in a national US study (29). Additional US studies indicate that factors affecting referrals to DSME by PCPs include lack of program awareness (20); lack of communication with DEPs (7,8); patients' unwillingness to attend (30); feeling responsible for patients' diabetes education (30); viewing DEP recommendations as conflicting with their own; and questioning the effectiveness of DEPs (30-32).

Given the critical role of PCPs in referring patients to DSME, referral practices and barriers to DSME participation need to be better understood as this body of literature is limited, particularly in Canada. Our primary research objective was to investigate PCP referral practices to DEPs and the factors influencing referral. Our secondary objective was to explore PCPs' barriers to caring for patients with diabetes. These objectives will identify whether gaps in DEP utilization exist and which strategies or models of care should be further explored in order to improve PCPs' comfort with and expertise in managing patients with diabetes.

METHODS

Design and study sample

This study employed a survey methodology to best accommodate PCPs and their busy work schedules. The survey was conducted in 2 adjacent regions, Peel and Halton, suburbs of Toronto, Ontario, Canada's largest city. All physicians serving this region were targeted. The sample was drawn from the Ontario Medical Association (OMA) membership list, with no exclusions. The OMA identified 1403 physicians (55% PCPs and 45% specialists), a sampling frame based on the geographical parameters of the Mississauga Halton Local Health Integration Network (MH-LHIN). The OMA sent the survey to physicians on behalf of the authors, as physician information is kept confidential. Physicians were contacted by regular mail, e-mail or fax, depending upon their communication instructions to the OMA. It was at the discretion of each physician to complete the survey. Physician surveys were received either online (via Survey Monkey) or by fax. Respondents were entered to win a CAN\$250 voucher for a restaurant of their choice.

Of the 1403 physicians, 149 responded, yielding a response rate of approximately 10%. Because PCPs usually diagnose diabetes and provide care to patients with diabetes, only responses from PCPs were analyzed. Data from 45 (30%) of the 149 respondents who identified themselves as specialists were omitted from the analysis. In addition, data from 5 respondents (3%) who did not specify whether they were PCPs or specialists were also omitted. The final sample consisted of 99 PCPs (66% of total respondents), or a response rate for PCPs of 13%.

Measurements

Survey questions, developed in conjunction with the MH-LHIN, Diabetes Education Task Group, were based on a thorough literature review on the topic of physician referral to DSME. A preliminary survey was posted on the MH-LHIN website and pretested in June 2008 for comprehension and clarity before the questionnaire was finalized. The final questionnaire was distributed to physicians in one of 3 ways based on physician preference as outlined by the OMA mailing list: e-mail, which included an Internet survey link; regular mail; or fax. The survey consisted of multiple-choice questions regarding various issues of patient referral. An "other" option for each question enabled respondents to elaborate or add more responses. In addition, the questionnaire offered PCPs the opportunity to provide suggestions on how to improve DEP utilization.

Data analysis

All analyses were conducted using SPSS version 14.0 [IBM, Chicago, Illinois]. Frequency counts and percentages were tabulated for all responses. Open-ended questions and all "Other" responses were sorted into categories and themes, using thematic analysis, by 2 of the authors (SK and VC). Any discrepancies were resolved by the first author (EG).

RESULTS

Sample characteristics

In our sample of 99 PCPs, 65% worked in a family health group, 12% in independent practice, 10% in a family health team, 5% in a family health organization, 3% in a walk-in clinic or community health centre, 2% in a comprehensive care model, 2% in a hospital and 1% in a family health network.

PCP referral patterns

Self-reported referral rates to DEPs were high, with almost all PCPs (96%) indicating that they referred at least some of their patients to DEPs. However, when asked which patients they most commonly referred (they were able to select all responses that applied), only 46% stated that they referred all of their patients to DEPs. Other common responses indicated that PCPs referred those who would benefit from re-education (80%), were newly diagnosed with type 2 diabetes (77%), had type 2 diabetes requiring insulin (76%), were newly diagnosed with type 1 diabetes (72%), had gestational diabetes (47%) or prediabetes (39%) (Table 1).

Factors influencing PCP referral

The majority of PCPs (74%) reported that patients themselves were unwilling to attend DEPs, but PCPs also reported DEP-related barriers to referral, such as the inability of DEPs to serve patients in their native language (28%),

waiting lists of more than 2 weeks (23%) or no evening or weekend appointments (17%). PCPs also reported that they did not refer their patients because they provided diabetes education themselves (12%) and because of the long referral process (9%) (Table 2). In an open-ended question, PCPs suggested that the referral process can be simplified by having forms readily available, reducing the use of special forms, accepting patients with or without copies of blood work, and using the same referral forms and procedures across all DEPs.

Table 1. PCP patterns of referral to DEPs* (n=99)

Answer options	Responses, n (%)
Patients who would benefit from re-education	79 (80)
Patients with newly diagnosed type 2 diabetes	76 (77)
Patients with type 2 diabetes requiring insulin	75 (76)
Patients with newly diagnosed type 1 diabetes	71 (72)
Patients with gestational diabetes	46 (47)
All patients with diabetes	45 (46)
Patients with prediabetes	39 (39)
Patients having trouble with their diabetes	20 (20)
Patients with steroid-induced diabetes	16 (16)
Patients whose cases are special or difficult	3 (3)
Nobody	1 (1)

*Respondents were able to select all answers that applied

DEP = diabetes education program
PCP = primary care physician

Table 2. PCP reasons for not referring patients to DEPs* (n=69)

Answer options	Responses, n (%)
Patients unwilling to attend	51 (74)
Language barrier	19 (28)
Long waiting list (>2 weeks)	16 (23)
Times unsuitable (no evening/weekend appointments)	12 (17)
Able to provide diabetes education in-house	8 (12)
Location is difficult for patients to get to	7 (10)
Parking issues	6 (9)
Referral process	6 (9)
I don't know what services are offered	3 (4)
Patient does not need service	3 (4)
Limited services available at the DEP	1 (1)

*Respondents were able to select all answers that applied

DEP = diabetes education program
PCP = primary care physician

Table 3. Patient barriers to attending DEPs, as reported by PCPs* (n=85)

Answer options	Responses, n (%)
Times unsuitable (no evening/weekend appointments)	45 (53)
Language barrier	23 (27)
Location not convenient	18 (21)
Not helpful to patient	18 (21)
Parking issues	13 (13)
Patient uses other sources of diabetes education	13 (13)
All patients attend DEPs	12 (12)
Patients do not give reasons	11 (11)
Unmotivated or nonadherent patients	10 (10)
Time constraints	2 (2)
I have never asked my patients this question	1 (1)
Transportation barriers	1 (1)

*Respondents were able to select all answers that applied

DEP = diabetes education program

PCP = primary care physician

Patient barriers to attending DEPs

When asked about patient barriers with respect to attending DEPs, PCPs' most frequent responses pointed to DEPs' inconvenient hours of operation, such as a lack of weekend or evening services (53%); language barriers between DEP staff and patients (27%); inconvenient DEP locations (21%); and DEP attendance being unhelpful to patients (21%). Only 12% of PCPs stated that all their patients attended DEPs (Table 3).

PCP barriers to caring for patients with diabetes

PCPs' most frequently reported barrier to caring for patients with diabetes was lack of time to assess complex patient cases (58%). PCPs also reported lack of coverage for diabetes medications, either under the Ontario Drug Benefit (55%) (which covers those by the *Health Insurance Act* and are 65 years of age or older) or via third-party insurance (36%). Limited knowledge of insulin starts and adjustments was another common issue affecting PCP care for patients with diabetes (53%). Respondents also reported limited access to foot-care specialists (44%), lifestyle counselling/education (35%), mental health specialists (24%) and diabetes educators (23%) (Table 4).

PCP suggestions to improve DEPs

In the open-ended questions, almost one-third (30%) of participating PCPs reported being satisfied with the services provided by DEPs. The most common suggestions to improve DEPs overlapped with the findings from the previous questions: shorter waiting periods, increased access to DEP

Table 4. PCP barriers to caring for patients with diabetes (n=66)

Answer options	Responses, n (%)
Lack of time to assess complex patient cases	38 (58)
Limits to provincial-government coverage of diabetes drugs	36 (55)
Limited knowledge of insulin starts and adjustments	35 (53)
Difficulty in accessing foot-care specialist for referrals	29 (44)
Limits to third-party insurance coverage of diabetes drugs	24 (36)
Difficulty accessing lifestyle counselling and education for referrals	23 (35)
Difficulty accessing mental health specialist for referrals	16 (24)
Difficulty accessing diabetes educator for referrals	15 (23)
Difficulty accessing specialist for referrals	7 (11)
Time constraints	2 (2)
I have never asked my patients this question	1 (1)
Transportation barriers	1 (1)

*Respondents were able to select all answers that applied

PCP = primary care physician

services (i.e. evening and weekend hours), a faster referral process, and more culture- and language-specific care. Other suggestions included better promotion of DEP services to patients and PCPs, programs for specialized groups (e.g. prediabetes) and onsite education in PCP offices.

DISCUSSION

Ninety-six percent of PCPs in our study reported referring some patients with diabetes to a DEP, but only 46% reported referring all of their patients with diabetes. This finding signifies that less than half of the PCPs in our study followed the 2008 Canadian Diabetes Association clinical practice guidelines (1), which recommend DSME for *all* patients diagnosed with diabetes. The rates found in our study are higher than others reported across North American studies, a variation that may be due to differences in methodology. For example, a referral rate of 52% was reported in Harris and colleagues (5), a Canadian national study that used a self-report survey that examined the referral of patients at risk for or with type 2 diabetes to DEPs using a scenario question (e.g. "I would use in my practice ... I would refer patients to diabetes education centre or registered nutritionist or dietitian"), whereas we investigated self-reported referrals of patients with type 1, type 2 or gestational diabetes. It is interesting to note that the percentage of physicians who referred all of their patients in this study is similar to the

52% who said they would refer under a hypothetical situation in the Harris study, raising the question whether PCPs may be over-reporting referrals to DSME, given that this is the major limitation of scenario-based research (33). A cross-sectional study by Rabi and colleagues (28), who reported a referral rate of 14%, used a combination of administrative data (i.e. DEP database, data on diabetes prevalence from a provincial health surveillance database and federal census data) to measure referral and DEP attendance of patients with any type of diabetes to 1 regional DEP in Calgary, Alberta. Peyrot and colleagues (29) surveyed both PCPs and diabetes specialists and reported a referral rate of 45%; however, diabetes specialists in this study may have been less likely to refer to DEPs, because 65% of specialists had a diabetes educator on-site. Consistent methodologies across studies are necessary to better assess and compare referral rates across North America and within countries.

In addition to inquiring about referral rates, we also asked about the types of diabetes patients PCPs most commonly referred to DEPs. We found that a large proportion of PCPs referred newly diagnosed patients with both type 1 or type 2 diabetes. This is consistent with the literature, as an Ontario-based study found that an independent predictor of DEP attendance is recent diagnosis of diabetes (19).

DSME is a resource that emphasizes the prevention of diabetes complications and comorbidities; how PCPs use these resources needs to be better understood. For example, PCPs may not be aware of the programs and services that are available from DEPs. One engagement strategy might be for DEPs to inform PCPs of their programming focus, as ministry-funded DEPs are not only mandated to provide education, but also to focus on helping patients self-manage their disease. Unfortunately, DEPs are not standardized with respect to funding or programming across regions. Increasing PCPs' awareness of the variety of programs that exist in their area and building on existing programs to offer standard programming across regions are 2 main objectives of the newly formed Diabetes Regional Coordinating Centres in Ontario. The recent implementation of the Baseline Diabetes Dataset Initiative, the Ontario Ministry of Health and Long-Term Care's report card for diabetes by physicians, will allow PCPs to become more aware of their practice gaps in diabetes management and may encourage them to obtain support from local DEPs.

Our study results suggest that PCP referral practices to DEPs are largely influenced by patient factors. We found an overlap between the PCPs' reasons for not referring to DEPs and PCP-reported patient reasons for not attending. This overlap relates to both patients' needs and the characteristics of DEP operations, both of which affect referral decisions. The identified overlapping barriers were a lack of evening/weekend DEP operations, inability of DEPs to

serve patients in a range of languages, and inconvenience of DEP locations. Other research has led to similar findings: that patients are less willing to attend DEPs if they perceive that services are culturally limited (30,34-37) and if the DEP location is inconvenient (30,31). DEPs may be able to increase attendance by developing and delivering services that are culturally relevant, and conveniently timed and located (30,38).

While patient barriers were often cited as factors influencing referral practices, PCPs also identified challenges in DEP referral processes and services. Eliminating complicated referral procedures (i.e. special referral forms, attaching lab results with referral and nonstandardized referral forms) and allowing patients to self-refer by removing requirements for physician or endocrinologist referrals as a prerequisite to participation can increase DEP utilization. The literature also echoes the need to streamline the referral process (31,32).

In Canada, the physician-to-patient ratio is 2.2 per 1000 people, similar to findings from the US (39). Therefore, it is not surprising that in our study and others (10,40) the most significant barrier to caring for patients with diabetes identified by PCPs is lack of time. Most PCPs feel they do not have enough time to teach diabetes self-management (10,37,40). In fact, in a Canadian survey conducted in 2007, 80% of physicians reported that managing patients with chronic diseases and complex medical conditions increased their time demands (9). In our study, 53% of PCPs reported that they had limited knowledge relating to insulin starts and adjustments. This is similar to another Canadian study in which PCPs reported limited training in and knowledge of how to deal with complex diabetes cases, as well as limited knowledge about insulin therapy (10). Overall, the limited time and lack of diabetes-specific knowledge reported by PCPs underscores the need for DSME to be delivered by DEPs (36,40). It is evident from our results that PCPs face major barriers to care that can be relieved by referrals to DEPs. In contrast to PCPs, diabetes educators (who work primarily at DEPs) have reported spending half of their time educating patients and setting management goals (41). Moreover, a United Kingdom study found that participating diabetes patients valued healthcare professionals, such as nurses, who took the time to teach diabetes self-management (42).

A minority of PCPs in our sample practiced in family health teams (FHTs), a unique model of care for patients with diabetes based on government funding. Even though many FHTs have in-house nurses and dietitians, they still work with local DEPs to provide ongoing support and reinforcement of disease management messaging, as well as medical management to their patients. For instance, DEPs make recommendations about treatment regimens, and FHTs are responsible for executing those recommendations. Thus, prioritizing the development of partnerships between

PCPs and diabetes educators, regardless of the type of PCP practice setting, would improve patient care. DEPs should ameliorate local efforts to manage diabetes by expanding their community outreach services to liaise with PCPs in various settings and within their communities (i.e. churches, libraries, pharmacies, etc). This would increase awareness of DEP services among PCPs and those living with diabetes in the local community.

A limitation of this study, which is typically encountered in studies involving physician surveys (43), was the low response rate of 10%. A low response rate raises concerns regarding the external validity of the survey findings. If respondents differ from non-respondents in aspects related to study outcomes, a low response rate could introduce non-response bias (44). Given that we were not allowed to contact physicians directly, we did not have a list of respondents and non-respondents to compare characteristics. Furthermore, survey participants were promised anonymity. Nevertheless, several physician surveys have shown that higher response rates are not necessarily associated with lower non-response bias (45-47). In addition, Kellerman and Herold (48) suggest that studies that measure non-response bias by examining demographics of early and late survey respondents (49) identify little or no response bias. Thus, non-response bias may be less of a concern in physician surveys than in surveys of the general population; responding and non-responding physicians tend to be more homogeneous in terms of training, knowledge, attitudes and behaviours (48). Variation among physicians may be less associated with willingness to respond or with survey content than among the general population (48).

In addition, because we sampled PCPs in only 1 region of 1 province in Canada, our results are limited in their generalizability due to possible regional and geographical differences in referral procedures and PCP practice settings. Our study sample under-represented PCPs who practice independently (12%) as compared to the MH-LHIN region (33%) and Ontario (30%) (50), although the majority of PCPs practice in family health groups (65%) as in the MH-LHIN region (52%) and Ontario (57%) (50). The under-representation of independent practitioners and slight over-representation of family health group practitioners may be the result of volunteer bias from the latter group. Many of the other practice settings are not categorized in a similar fashion and difficult to compare with LHINs and Ontario data. Lastly, our results are based on self-reporting by PCPs and, thus, may have been affected by recall and social desirability bias.

CONCLUSION

Our results demonstrate that, although almost all PCPs reported referring some of their patients to DEPs, fewer than half referred all of their patients with diabetes. The low

referral rate indicates that not all patients with diabetes are receiving the multidisciplinary care they need to effectively manage their chronic illness and prevent complications. Although PCPs view DSME as an important aspect of diabetes care, patient reluctance and operational barriers, such as lack of cultural and language-specific services, long waiting lists and inflexible service hours, in addition to PCP dissatisfaction with the referral process, are some substantive reasons negatively influencing referral.

Ideally, DEPs should provide counselling, support services and resources to meet the needs of the community they serve; some PCPs in the current study perceived that the lack of such services was a barrier to patients' participation in DEPs. This may mean, for example, adopting culturally appropriate resources and services, providing flexible hours of service and an accessible location. Having diabetes educators at the same site or near PCPs may also improve PCP referral and patient participation. These types of service models will ensure PCPs' ability to access diabetes educators, as well as create an outreach opportunity for patients with diabetes. This study not only provides evidence that patients with diabetes are receiving less than optimal diabetes care, but also provides some insight into how to improve the situation, since the majority of barriers reported by PCPs are modifiable.

AUTHOR DISCLOSURES

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AUTHOR CONTRIBUTIONS

SJS, SH and EG contributed to the conception and design of the study. EG, VC and SK analyzed the data. EG, VC, MF and SK wrote the first draft of the manuscript. All authors reviewed the draft critically for important intellectual content and approved the final version to be published.

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ORIGINAL RESEARCH

Diagnosis and Management of Obesity: A Survey of General Practitioners' Awareness of and Familiarity with the 2006 Canadian Clinical Practice Guidelines

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ABSTRACT

OBJECTIVE: This study assessed Nova Scotia's general practitioners' awareness of and familiarity with the 2006 *Canadian Clinical Practice Guidelines on the Management and Prevention of Obesity in Adults and Children*. It also explored the frequency with which general practitioners measured adult or pediatric weight, calculated adult or pediatric body mass index (BMI), and measured adult waist circumference in overweight and obese patients.

METHODS: A random sample of 425 office-based general practitioners was selected to complete a mailed questionnaire.

RESULTS: Overall, 37.5% of respondents reported being aware of the guidelines. Those who were aware of the guidelines were significantly more likely to calculate pediatric or adult BMI than those who were not. The mean familiarity rating was low: the higher a respondent's familiarity with the guidelines, the more likely that pediatric weight would be measured and pediatric BMI calculated. Respondents with access to electronic medical records (EMRs) were more likely to calculate BMI and measure adult waist circumference than those without EMRs.

CONCLUSIONS: General practitioners' awareness of and familiarity with the guidelines was low, but for those who were aware of them, the guidelines had a significant impact on the frequency of some of the recommended assessments.

KEYWORDS: guidelines, knowledge translation, obesity, primary care

RÉSUMÉ

OBJECTIF: Cette étude visait à déterminer si les omnipraticiens de la Nouvelle-Écosse étaient au courant de l'existence des *Lignes directrices canadiennes de 2006 sur la prise en charge et la prévention de l'obésité chez les adultes et les enfants* et s'ils les connaissaient bien. Elle a aussi porté sur la fréquence de la

détermination du poids des adultes et des enfants, du calcul de l'indice de masse corporelle (IMC) chez les enfants et les adultes et de la mesure du tour de taille chez les patients en surpoids ou obèses par les omnipraticiens.

MÉTHODES : Un questionnaire a été posté à un échantillon aléatoire de 425 omnipraticiens exerçant en cabinet privé.

RÉSULTATS : Globalement, 37,5 % des répondants ont dit être au courant de l'existence des lignes directrices. Les médecins qui étaient au courant de l'existence des lignes directrices étaient significativement plus susceptibles de calculer l'IMC chez les enfants et les adultes que ceux qui ne l'étaient pas. La cote de familiarité moyenne était faible : plus les lignes directrices étaient familières à un répondant, plus il était susceptible de déterminer le poids et de calculer l'IMC chez les enfants. Les répondants qui avaient accès à des dossiers médicaux électroniques étaient plus susceptibles de calculer l'IMC et de mesurer le tour de taille chez les adultes que ceux qui n'avaient pas accès à de tels dossiers.

CONCLUSIONS : Peu des omnipraticiens de la Nouvelle-Écosse étaient au courant de l'existence des lignes directrices et connaissaient bien les lignes directrices, mais chez ceux qui étaient au courant de leur existence, les lignes directrices influençaient beaucoup sur la fréquence de certaines des évaluations recommandées.

MOTS CLÉS : lignes directrices, transfert des connaissances, obésité, soins primaires

INTRODUCTION

Nova Scotia has one of Canada's highest rates of obesity (1,2), a chronic disease that has been shown to have a significant impact on the risk of developing other comorbidities, including type 2 diabetes. In a recent systematic review, overweight and obesity in childhood and adolescence were

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associated with a significant increase in risk of morbidity in adult life, including diabetes, hypertension, ischemic heart disease and stroke (3). A 10-year follow-up (4) of middle-aged women in the Nurses' Health Study (5) and men in the Health Professionals Follow-up Study (6) assessed the health risks associated with overweight and found that the incidence of several comorbidities, including diabetes, increased with the degree of overweight in both men and women.

The management of obesity is challenging for healthcare providers for many reasons, even when it comes to addressing the issue with patients in the first place (7-19). Clinical practice guidelines are intended to aid practitioners (20,21), but the usefulness of these guidelines depends on practitioners' awareness of their existence and subsequent familiarity with their contents (22). Research has shown rates of awareness and/or familiarity with guidelines ranging from a low of 16% to a high of 65% (23-26).

The 2006 Canadian Clinical Practice Guidelines on the Management and Prevention of Obesity in Adults and Children recommend "measuring [body mass index (BMI)] and waist circumference" as a "grade A recommendation when screening for overweight and obesity in individuals" (27), a practice that in reality appears to occur infrequently both in the pediatric and adult populations (28-31). This study assessed general practitioners' awareness of and familiarity with these guidelines, and the frequency with which they measured adult or pediatric weight, calculated adult or pediatric BMI and measured adult waist circumference (WC) in overweight or obese patients. It also aimed to determine what factors might contribute to the frequency of these physician practices.

METHODS

A search of the College of Physicians and Surgeons of Nova Scotia's register of licensed physicians in Nova Scotia identified 766 office-based general practitioners in active practice in January 2010. Given the traditionally low response rate to mailed surveys and in order to increase the likelihood of an adequate final sample for analysis, 425 physicians, representing over 50% of the population, were randomly selected. These physicians received a card by mail advising them that they had been randomly selected to participate in this study. Three days later, a brief questionnaire (available upon request) was mailed to them, along with a stamped return envelope. This was followed up with a reminder 14 days after the original mailing.

The survey instrument assessed general practitioners' awareness of and familiarity with the 2006 guidelines (27), as well as their practices with regard to assessing overweight and obesity in their patients. Table 1 describes the types of data collected.

Response rates and summary descriptive statistics

describing the frequency of survey results were then calculated and the data analyzed to determine whether:

- Demographic variables were predictors of awareness of the guidelines.
- Demographic variables were predictors of familiarity with the guidelines.
- Awareness of the guidelines was a predictor of frequency of assessment practices.
- Familiarity with the guidelines was a predictor of frequency of assessment practices.
- Demographic variables were predictors of the frequency of assessment practices.

Table 1. Data collected in the survey instrument

<ul style="list-style-type: none"> • Awareness of the guidelines (1=yes, 2=no) • Familiarity with the guidelines (rating on a scale of 1=not at all familiar to 5=very familiar) • Frequency of the following assessment practices (rating on a scale of 1=on no patients to 5=on all patients): <ul style="list-style-type: none"> – Measuring pediatric weight – Measuring adult weight – Calculating pediatric BMI among patients for whom weight is known – Calculating adult BMI among patients for whom weight is known – Measuring adult WC • Demographic variables: <ul style="list-style-type: none"> – Respondent age – Respondent BMI – Number of years in practice – Average number of patients seen per week – Sex (1=female, 2=male) – Use of EMRs (1=yes, 2=no) – Urban or rural practice (1=urban, 2=rural) – Group or solo practice (1=group, 2=solo) – Working with a nurse in the practice (1=yes, 2=no)

BMI = body mass index

EMR = electronic medical records

WC = waist circumference

The data were analyzed so as to minimize the problem of compounding error rates with multiple statistical tests of a single dataset. Where possible, multivariate analysis of variance (MANOVA) (with a criteria of $p < 0.1$) was conducted, followed by univariate analyses (with a criteria of $p < 0.05$) or multiple regression analyses. In the case of multiple regression analyses, all predictor variables were entered in a single step, followed by stepwise backward removal of nonsignificant predictors to overcome the problem of attributing all shared variance to the initial variable entered into a forward stepwise regression procedure. When multivariate analyses were not possible, correlations, chi-square or t-test statistics were calculated.

RESULTS

Of the 425 surveys mailed out, 157 were returned, representing a 36.9% response rate. Five respondents were excluded from the analysis, as they were not in office-based general practice. As a result, a total of 152 surveys were analyzed.

The mean age of respondents was 48.8 years (SD=9.0), and mean respondent BMI was 25.9 kg/m² (SD=4.6). The mean number of years in practice was 22.8 (SD=9.3), and the mean number of patients seen per week was 199.9 (SD=81.4). Respondents were evenly represented with respect to sex (52.3% male), practice location (51.7% urban) and availability of electronic medical records (EMRs) (52.3% no). A majority of respondents (68.5%) practiced in group rather than solo practice, and two-thirds (66.7%) did not collaborate with a nurse in their practice.

Approximately one-third of respondents (37.5%) reported being aware of the 2006 guidelines (27). Among those who were aware of the guidelines, the mean familiarity rating was 2.72 (SD=0.92) on a scale of 1 (not at all familiar) to 5 (very familiar).

Analyses of the relationship between demographic variables and awareness of the guidelines showed that those with access to EMRs were more likely to be aware of the guidelines than those without ($\chi^2=5.33$, $p=0.02$).

The relationship between demographic variables and familiarity with the guidelines was examined and revealed that physicians in urban practices were significantly more familiar with the guidelines than rural physicians ($t=2.087$, $p=0.039$). In addition, there was a trend for younger physicians to be more familiar with the guidelines than their older counterparts ($\beta=-0.146$, $t=-1.703$, $p=0.091$).

Mean scores for the frequency of assessment practices and

the percent distribution on the frequency scale are shown in Table 2. Respondents reported measuring weight in adult patients significantly more often than in pediatric patients ($t=-8.208$, $df=148$, $p<0.001$). Similarly, they reported calculating adult BMI significantly more often than pediatric BMI ($t=-8.818$, $df=150$, $p<0.001$).

Analyses of the relationship between awareness of the guidelines and frequency of assessment practices indicated that those who were aware of the guidelines were significantly more likely to calculate pediatric BMI or adult BMI than those who were not (Table 2).

Table 2 also illustrates the relationship between familiarity with the guidelines and frequency of assessment practices. The higher a respondent's familiarity rating, the more likely that pediatric weight would be measured and pediatric BMI calculated.

The relationship between frequency of assessment practices and demographic variables was examined and demonstrated a number of significant results. First, calculation of adult BMI was significantly correlated with age ($r=-0.184$, $p=0.025$), BMI ($r=-0.248$, $p=0.003$) and years in practice ($r=-0.169$, $p=0.044$). A partial correlation controlling for age decreased the significance of the correlation of years in practice ($r=-0.031$, $p=0.723$) and a partial correlation controlling for years in practice decreased the significance of age ($r=-0.034$, $p=0.699$). Second, physicians in group practice were more likely to measure adult WC than those

Table 2. Frequency of assessment practices

Assessment practice	On no patients, %	On very few patients, %	On some patients, %	On most patients, %	On all patients, %	Mean rating	SD
Pediatric weight	4.0	17.4	36.9	33.6	8.1	3.24	0.97
Pediatric BMI	7.9	23.8	29.1	20.5	18.5	3.18	1.22
Adult weight	0.7	3.3	25.0	57.9	13.2	3.80	0.73
Adult BMI	0	2.6	27.6	45.4	24.3	3.91	0.79
Adult WC	18.4	38.2	35.5	5.9	2.0	2.35	0.92

BMI = body mass index
WC = waist circumference

Table 3. Relationship between awareness of/familiarity with the guidelines and frequency of assessment practices

Assessment practice	Awareness of guidelines				Familiarity with guidelines	
	F	p	Mean rating (aware)	Mean rating (not aware)	Pearson correlation	p
Pediatric weight	2.93	0.089	3.42	3.14	0.17	0.043*
Pediatric BMI	8.08	0.005*	3.55	2.97	0.18	0.025*
Adult weight	0.30	0.584	3.86	3.79	0.02	0.827
Adult BMI	4.16	0.043*	4.09	3.82	0.12	0.141
Adult WC	1.32	0.253	2.46	2.28	0.08	0.340

*Significant

BMI = body mass index
WC = waist circumference

in solo practice ($F=6.110$, $p=0.015$). Third, physicians with access to EMRs were more likely to calculate pediatric BMI ($F=15.043$, $p=0.000$) adult BMI ($F=6.283$, $p=0.013$) and measure adult WC ($F=4.808$, $p=0.03$) than those without.

Based on the above results, a post-hoc multivariate regression was calculated for each of the following assessment practices: calculating adult BMI, calculating pediatric BMI and measuring adult WC. The following predictor variables were entered in a single step: awareness of the guidelines, familiarity with the guidelines, age, BMI, years in practice, number of patients per week, urban/rural practice, group/solo practice, sex, EMR, nurse. The final regression equations were significant: calculating pediatric BMI ($p=0.001$) was predicted by access to an EMR ($t=-3.160$, $p=0.002$); calculating adult BMI ($p=0.01$) was significantly predicted by respondent BMI ($t=-2.193$, $p=0.03$) and access to an EMR ($t=-2.027$, $p=0.04$); and measuring adult WC ($p=0.024$) was significantly predicted by group vs. solo practice ($t=-2.291$, $p=0.024$).

DISCUSSION

Previous studies have addressed the frequency with which general practitioners calculate overweight or obese patients' BMI and show a wide range in frequency of assessment (28-31). However, it is not clear whether previous results reflect the frequency of BMI calculation among all patients, among all overweight or obese patients, or among patients for whom height and weight measurements were available. Therefore, comparison between previous research and this study is difficult.

Of all assessment practices, measurement of WC occurred least frequently, in keeping with previous literature (32). This could be explained by an element of clinical awkwardness. For example, Dunkley and colleagues (33) found that the intimate nature of measuring WC and perception that patients might feel uncomfortable or embarrassed about having this measurement taken presented a barrier for some healthcare providers.

Calculation of BMI in adult patients was predicted by awareness of the guidelines, having access to EMRs, being a younger physician and having practiced for fewer years (the latter 2 factors are probably one and the same). Calculation of BMI in adult patients was also predicted by a physician's own BMI: the higher the physician's BMI, the less likely adult BMI would be calculated. This finding differs from the results of previous studies: Hash and colleagues (34) did not find that a physician's BMI affected health advice, and Forman-Hoffman and colleagues (7) showed that only physicians with a BMI <25 kg/m² would calculate BMI more frequently than physicians with a BMI >25 kg/m². However, this study is consistent with the literature on smoking (35,36), where it has been shown that physicians who

smoke are less likely to address smoking with their patients than physicians who do not smoke.

The frequency of measuring weight and calculating BMI was significantly higher for adult than pediatric patients. Previous research has demonstrated that clinicians are reluctant to address obesity in children, because it is viewed as a sensitive issue linked to parenting behaviours, and addressing obesity poses a potential threat to the doctor-patient relationship (17-37). Similar results have been published about clinicians' views of addressing obesity in adults (38). Whether clinicians perceive more significant barriers in addressing children vs. adult obesity needs to be evaluated further.

This study's findings regarding the significance of using EMRs merit some discussion. Awareness of the guidelines, measurement of WC and calculation of pediatric and adult BMI were all predicted by access to EMRs. Previous research has shown that the use of EMRs significantly increases documentation of BMI and subsequent management of obesity (39,40). This could be explained by the fact that EMRs will calculate BMI if height and weight are entered into appropriate fields, thus partially addressing the issue of lack of time commonly cited as a barrier in the management of overweight and obesity; in addition, EMRs can generate reminders to take measurements. However, it is unclear why awareness of the guidelines would be predicted by working with EMRs. One could speculate that the personality traits of clinicians who choose to integrate EMRs into their practices might differ in some relevant way from those who continue to use paper charts.

This study has several potential limitations. First, the response rate was low (36.9%). Physicians who took the time to respond were likely more interested in the subject than non-responders. Second, self-report data is inherently potentially biased. Therefore, it is likely that this survey may in fact represent the "best-case scenario," and general practitioners may be assessing BMI and WC even less frequently than indicated by the study results. Third, communication barriers in the survey instrument may have introduced bias, potentially yielding inaccurate results.

CONCLUSIONS

The results of this study showed that, in January 2010, Nova Scotia's general practitioners' awareness of and familiarity with the 2006 *Canadian Clinical Practice Guidelines on the Management and Prevention of Obesity in Adults and Children* (27) was low, but for those who were aware of them, the guidelines had a significant impact on the frequency of some assessments. It can take several years for guidelines to become integrated into mainstream clinical practice and, in light of the rising obesity epidemic, it may be worthwhile exploring barriers to general practitioners' implementation of the 2006 guidelines.

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AUTHOR DISCLOSURES

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ORIGINAL RESEARCH

Predicting the Future Burden of Diabetes in Alberta from 2008 to 2035

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ABSTRACT

OBJECTIVE: Predict diabetes prevalence and costs to assist in policy decision-making with respect to diabetes prevention and treatment strategies.

METHODS: The model was developed based on observed epidemiologic data (incidence, prevalence and mortality rates) and healthcare cost data from the Alberta Diabetes Surveillance System (ADSS) and population projections from Alberta Health and Wellness. Patterns of changing incidence and mortality from 1995 to 2007 were extracted from the ADSS data using regression models. Using these data, a cohort life table model of the Alberta population was created that projected the population's yearly progression into diabetic states for 5-year age bands, stratified for men and women. Diabetes prevalence and healthcare costs from the government perspective were projected for 2008 to 2035.

RESULTS: If current trends continue, overall diabetes prevalence in Alberta will more than double between 2007 and 2035 from approximately 4.5% to 11.1%, with the greatest increases in older adults (age ≥ 70). Healthcare costs were projected to increase by 237%, with the greatest proportional increase seen in total physician costs.

CONCLUSION: Using population projections and the ADSS provides useful insights into how population aging, rising incidence and decreasing mortality rates will increase the diabetes burden in Alberta.

KEYWORDS: Alberta Diabetes Surveillance System, diabetes, forecasting, healthcare costs, incidence, modelling, mortality, prevalence

RÉSUMÉ

OBJECTIF : Prévoir la prévalence du diabète et les coûts associés au diabète pour faciliter l'élaboration des poli-

tiques relatives aux stratégies de prévention et de traitement du diabète.

MÉTHODES : Le modèle a été développé à partir des données épidémiologiques (taux d'incidence, de prévalence et de mortalité) et des données sur les coûts des soins de santé de l'Alberta Diabetes Surveillance System (ADSS), ainsi que des projections démographiques du ministère de la Santé et du Bien-être de l'Alberta. À partir des données de l'ADSS, on a déterminé l'évolution de l'incidence et de la mortalité de 1995 à 2007 au moyen de modèles de régression. En se servant de ces données, on a créé un modèle de table de survie de cohorte pour la population albertaine afin de prévoir la progression annuelle vers les états diabétiques pour chaque tranche d'âge de cinq ans chez les hommes et chez les femmes. On a estimé la prévalence du diabète et les coûts des soins de santé connexes pour le gouvernement de 2008 à 2035.

RÉSULTATS : Si les tendances actuelles se maintiennent, la prévalence globale du diabète en Alberta aura plus que doublé en 2035 par rapport à 2007, passant d'environ 4,5 à 11,1 %, et la plus grande augmentation sera observée chez les personnes de 70 ans et plus. On prévoit que les coûts des soins de santé augmenteront de 237 % et que ce sera au chapitre du coût total des soins prodigués par les médecins qu'il y aura la plus grande augmentation proportionnelle.

CONCLUSION : Les projections démographiques et l'ADSS donnent des renseignements utiles sur la façon dont le vieillissement de la population, l'augmentation de l'incidence et la baisse des taux de mortalité accroîtront le fardeau du diabète en Alberta.

MOTS CLÉS : Alberta Diabetes Surveillance System, diabète, prévisions, coûts des soins de santé, incidence, modélisation, mortalité, prévalence

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INTRODUCTION

Diabetes is clearly on the rise, in Canada and around the world (1-7). Globally, forecasting models have shown that the prevalence of diabetes is steadily increasing, and it is not a localized chronic condition (8-12). The major contributors to this growing prevalence are obesity and aging populations, both of which increase the risk of type 2 diabetes. Diabetes is associated with higher use of general practitioners, specialist services, emergency services and hospitals (13), so that as diabetes prevalence increases, so will the costs related to increased utilization of health services, meaning that scarce resources may need to be reallocated. Economic forecasting models are therefore a valuable tool in policy decision-making to show how the diabetes epidemic may develop over time.

In the past, researchers have used Markov (14,15) and life table models (12) to project future outcomes in diabetes. The strength of a model is based on the quality of the assumptions incorporated. In Markov models, assumptions are based on transition probabilities, which determine a base cohort's rate of transitioning from one state to the next. With a life table approach, the model follows a base cohort and applies population probabilities that determine the rate of transition from one state to the next; usually, population transition probabilities are based on population-wide epidemiologic data. The robustness of any model depends on the quality of the transition probabilities and the data that produced them.

There are many different economic models for diabetes, such as the United Kingdom Prospective Diabetes Study (UKPDS) model (16), Centre for Outcomes Research Diabetes model (15) and Ontario Diabetes Economic model (17). These models are all based on epidemiologic data derived from the UKPDS data. As such, while assumptions may hold true in a clinical setting and in a specific population of individuals who have specific risk factors used in the UKPDS, these models may not accurately reflect the actual incidence, prevalence, mortality or costs related to diabetes in general populations today or after a given duration.

Moreover, models derived from UKPDS epidemiologic data (16) include estimates of reduced mortality and cardio-

vascular events associated with a reduction in glycated hemoglobin (A1C) for patients with type 2 diabetes. However, a growing number of large randomized, controlled trials have failed to demonstrate a causal relationship between clinically important reductions in A1C and improved outcomes (18-21).

The recent Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial even suggests potential harm associated with aggressive glycemic control in this patient population (19). The benefits of improved glycemic control for people with type 2 diabetes may therefore be overestimated in these models. To avoid some of these problems, we have analyzed Alberta health data sets to identify changes in the diabetes population over time. The aim of this study was to forecast diabetes incidence, prevalence, mortality and costs using Alberta diabetes surveillance data from 1995 to 2007.

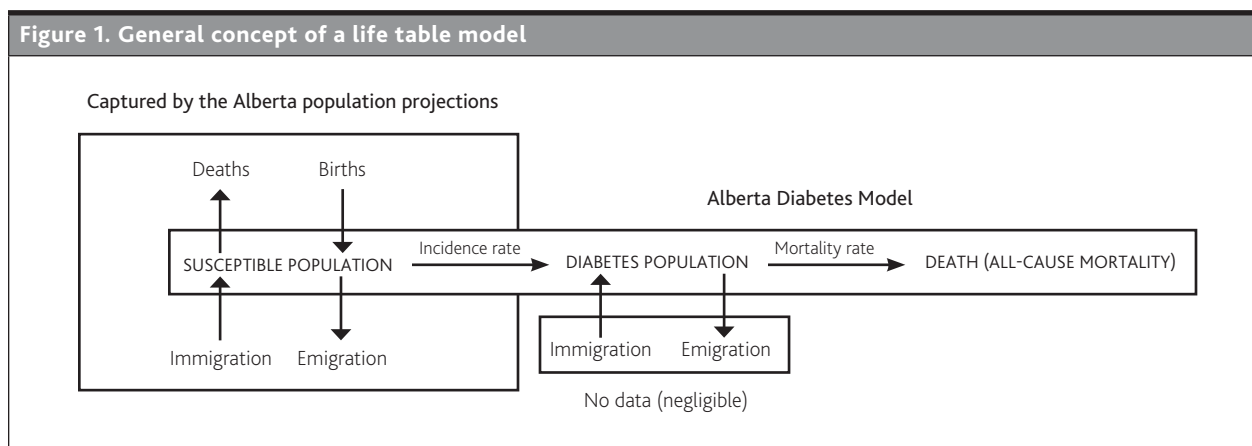
METHODS

Overview of the Alberta Diabetes Model

We developed a life table model (Figure 1) to predict the prevalence and costs of diabetes from 2008 to 2035. The model was created using incidence, prevalence and mortality rates and healthcare utilization and costs from the Alberta Diabetes Surveillance System (ADSS) (22), combined with population projections from Alberta Health and Wellness (23).

Two separate models were created, 1 each for women and men—who have been shown to have different rates and patterns of incidence, prevalence and mortality (6,22,24). The variables in the models included age-specific diabetes prevalence in the last observed year (2007) and historical (1995 to 2007) incidence and mortality rates, all estimated for 5-year age bands (except for the 1 to 4 age band). The projection model begins at 2008, and with each subsequent year, new incident cases are added and deaths are subtracted from the previous year's prevalence in each age band. At the end of each year, those in the last year of a given age band move to the next 5-year age band as prevalent cases in the new age band.

Figure 1. General concept of a life table model



Epidemiologic data

Four Alberta Health and Wellness databases were used to assemble de-identified, individual-level data on diabetes and related comorbidities and complications: the Discharge Abstract Database (hospital morbidity), Alberta Physician Claims Data, Ambulatory Care Classification System (which includes emergency room encounters) and Vital Statistics (which contains information on mortality) (25). Data were abstracted from 1995 to 2007.

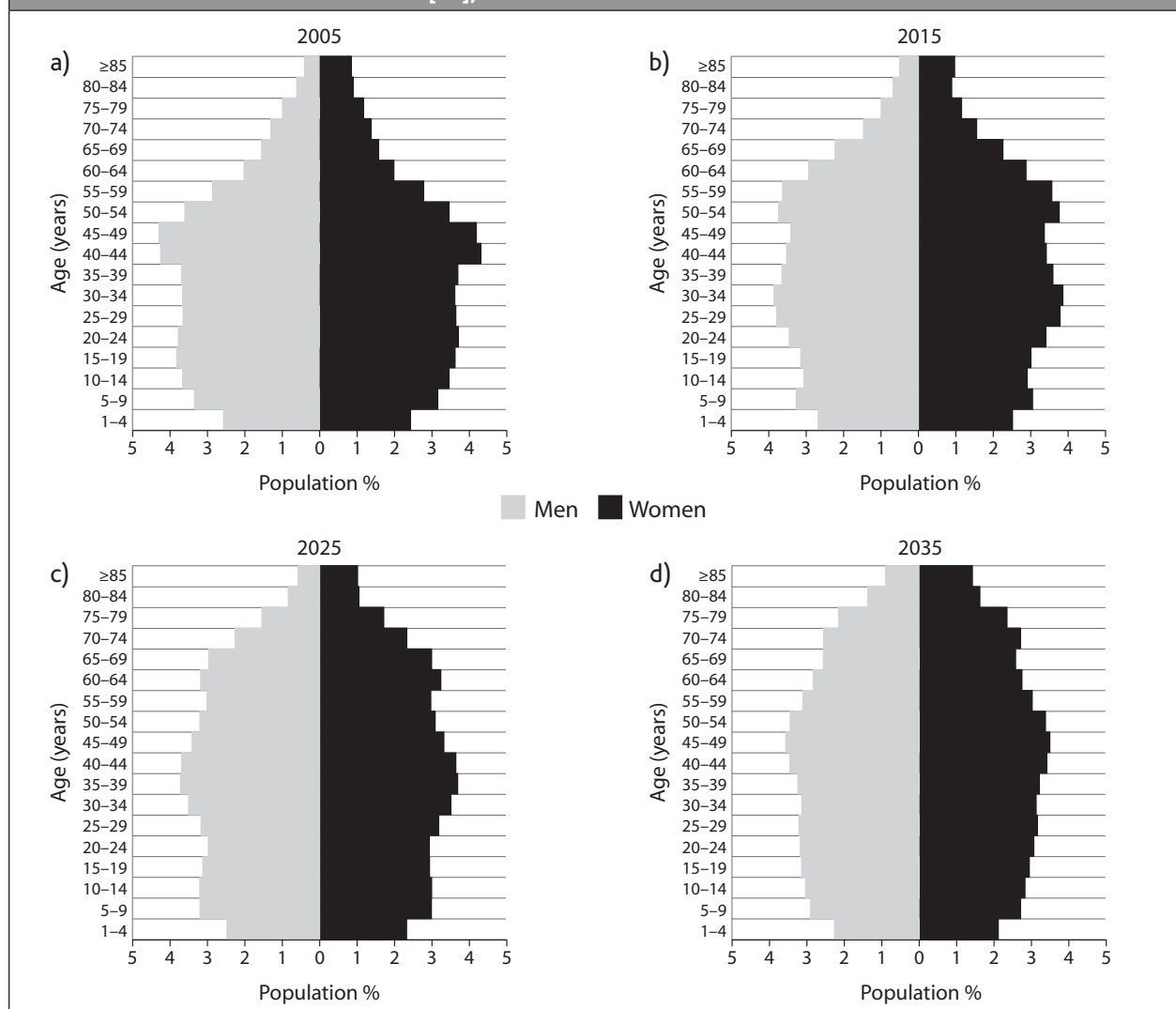
The validated National Diabetes Surveillance System diabetes case definition algorithm was applied (7,26). A diabetes case was identified as either (a) 1 hospitalization with an International Classification of Diseases 9th revision (ICD-9) of 250 (diabetes mellitus) for all available data for 1995 to 2001 or equivalent ICD, 10th revision codes (E10-14) for diabetes for the years after 2001 to 2002; or (b) 2 physician claims with an ICD-9 code of 250 (diabetes mellitus) within 2 years (25). Alberta Health and Wellness data also has

information on demographics (age, sex, health region, First Nations status) and healthcare utilization (hospitalization, physician services and ambulatory care), and the data were divided for diabetes and non-diabetes populations in Alberta (25). This allowed for the extraction of incidence, prevalence and mortality for diabetes in Alberta by age and sex, and included First Nations status populations (25).

Healthcare costs

Healthcare costs were separated into 3 main categories: total physician costs, emergency department costs and hospital costs. Cost categories were identified via monies paid directly through Alberta Health and Wellness (13). Total physician costs included both general and specialist physicians, and captured completed procedures performed for Alberta residents in either inpatient or outpatient settings (13). Hospitalization costs were estimated via resource intensity weights (RIWs) calibrated annually by the Canadian

Figure 2. Population distribution of Alberta in a) 2005, b) 2015, c) 2025 and d) 2035 (from Public Health Surveillance and Environmental Health [23])



*Data are actual for 2005 and projected for 2015, 2025 and 2035

Institute of Health Information (CIHI) (13). The RIWs that measured the resources used to treat certain case mix groups of patients were then multiplied by a dollar amount or the estimated cost per weight case (13). Emergency department costs were estimated based on an average cost of \$225 per emergency department visit, as established by Alberta Health and Wellness (13). These calculated healthcare costs included both diabetes- and nondiabetes-related costs.

Projections of incidence and mortality rates

The changing incidence rates of the model follow as closely as possible the trends seen in 1995 to 2007. Various regression techniques were performed on the aggregate-level incidence and mortality data, and the formula of the line of best fit was applied to the model. Based on patterns observed in the ADSS, incidence rates for the population <50 years of age were assumed to increase linearly over time, while those for the population ≥50 years of age were assumed to have a logistic shape, and maximum incidence was restricted to no higher than 30% of the highest incidence in 1995 to 2007 for both women and men. Mortality rates were assumed to have an exponential pattern. The fit of the estimated rates (incidence and mortality) was compared with observed rates, and the percent difference was calculated. The model slightly (0.5% to 1%) underestimated incidence and mortality for both women and men. Changes in incidence and mortality were assumed to occur in the first 8 years (2008 to 2015), and thereafter they were assumed to be constant. Based on these assumptions, diabetes prevalence projections were extended to 2035 for each sex and age group. For this analysis, we combined the male and female models into 1 population figure.

Population effects on prevalence rates

The population structure of Alberta is predicted to change from 2005 to 2035 (Figure 2). To isolate the effects of aging on diabetes prevalence, 2 scenarios were considered: a) application of 2035 age-specific prevalence rates to the 2007 population structure/population (the last observed year of data) and b) application of 2035 age-specific prevalence rates to the 2035 population structure with 2007 population numbers.

RESULTS

The Alberta Diabetes Model (ADM) predicted that the total number of people with diabetes will increase by 248% from 2007 (147 498 people) to 2035 (513 433 people) (Table 1). The overall diabetes prevalence in Alberta will more than double between 2007 and 2035, from approximately 4.5% to 11.1%. The largest increase in total number of people with diabetes is predicted to be in the older age bands (age ≥65), increasing by over 300% from 2007 to 2035 (Table 1, Figure 3). For the population <20 years of age, a rapid increase in total number of people with diabetes is predicted, with a more than 130% increase from 2007 to 2035. The largest increase is projected for the 5 to 9 age band, with a 188% increase from 2007 to 2035. The most rapid increase in prevalence will occur between 2015 to 2025 in older age bands (age ≥65) (Table 1, Figure 3).

As the number of individuals with diabetes increases relative to population growth, the prevalence in Alberta is also predicted to increase over time (Figure 4). Initially in 2008, the age band with the highest prevalence is predicted to be the 80 to 84 age group, and prevalence in subsequent age bands is seen to decline. However, over time the pattern of prevalence in Alberta changes substantially. By 2015, it is predicted that 75- to 79-year-olds will have the highest prevalence, accompanied by a levelling off of prevalence in the 80 to 84, and ≥85 age bands (Figure 4). In 2025 and 2035, the prevalence in the 75 to 79, 80 to 84, and ≥85 age bands are in a linear increasing pattern, with a prevalence of over 40% in the ≥85 age band in 2035 (Figure 4).

These crude rates incorporate changing population demographics: in 2005 a majority of the population was <50 years of age, while in 2035 the population structure is predicted to be almost evenly distributed (Figure 2). This changing population structure is predicted to change the current increased prevalence of diabetes in younger age groups (<55 years of age) to older age groups (≥55 years of age) in the future. Combined with the high incidence of diabetes in older age bands, the result will be higher prevalence over time (Table 1, Figures 3 and 4).

Age-adjusted prevalence was calculated based on a standardized population, eliminating the population effects on

Table 1. Number of people with diabetes in Alberta by age group (2008–2035)

	Age group (years)													Total*	
	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84		≥85
2007	1317	1923	3296	5425	8565	12 008	15 214	18 124	17 718	16 524	15 440	13 443	9436	6973	147 498
2008	1410	2059	3492	5778	8823	12 749	16 527	19 276	19 574	18 045	16 406	14 426	10 147	7759	158 830
2015	1902	3029	5296	8262	11 831	16 689	23 806	30 974	33 656	32 191	27 278	21 556	15 464	14 236	249 435
2025	2424	3761	7046	11 851	17 025	22 415	29 627	40 426	51 185	56 354	52 034	41 388	28 142	26 036	394 278
2035	2980	4353	7563	12 890	19 792	27 504	36 165	46 654	56 890	66 398	70 567	64 039	47 448	44 985	513 433

* Includes children with diabetes

Figure 3. Number of people with diabetes in Alberta by age band

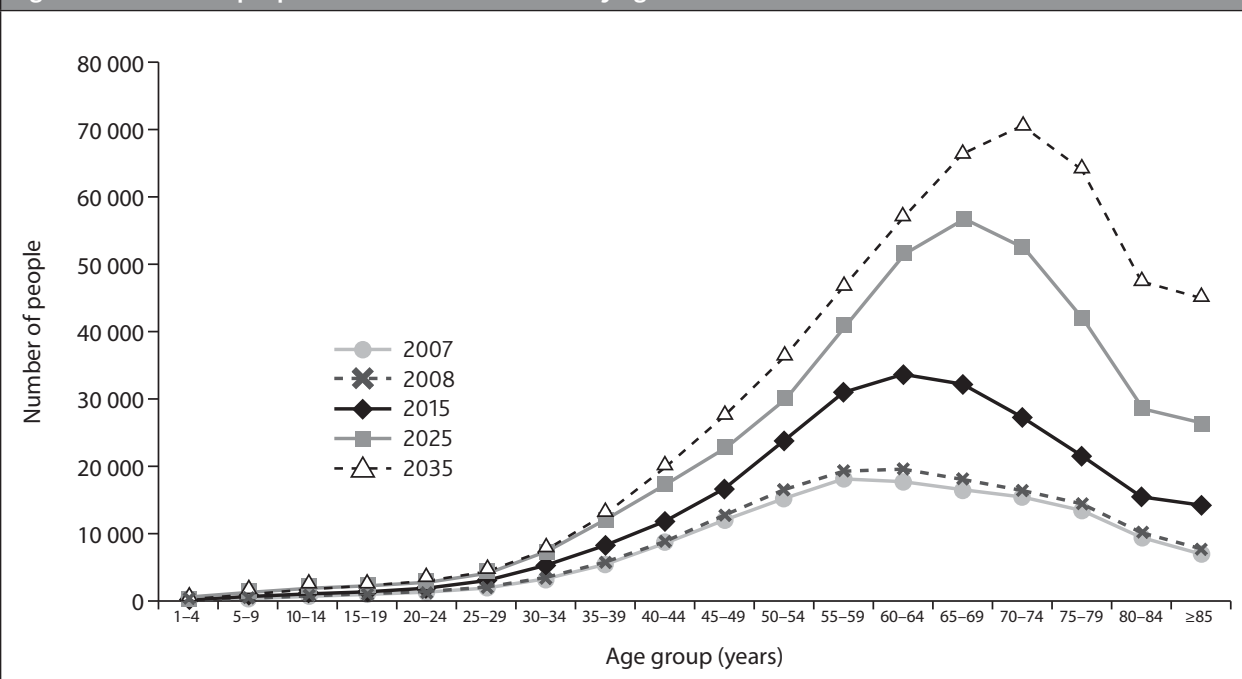
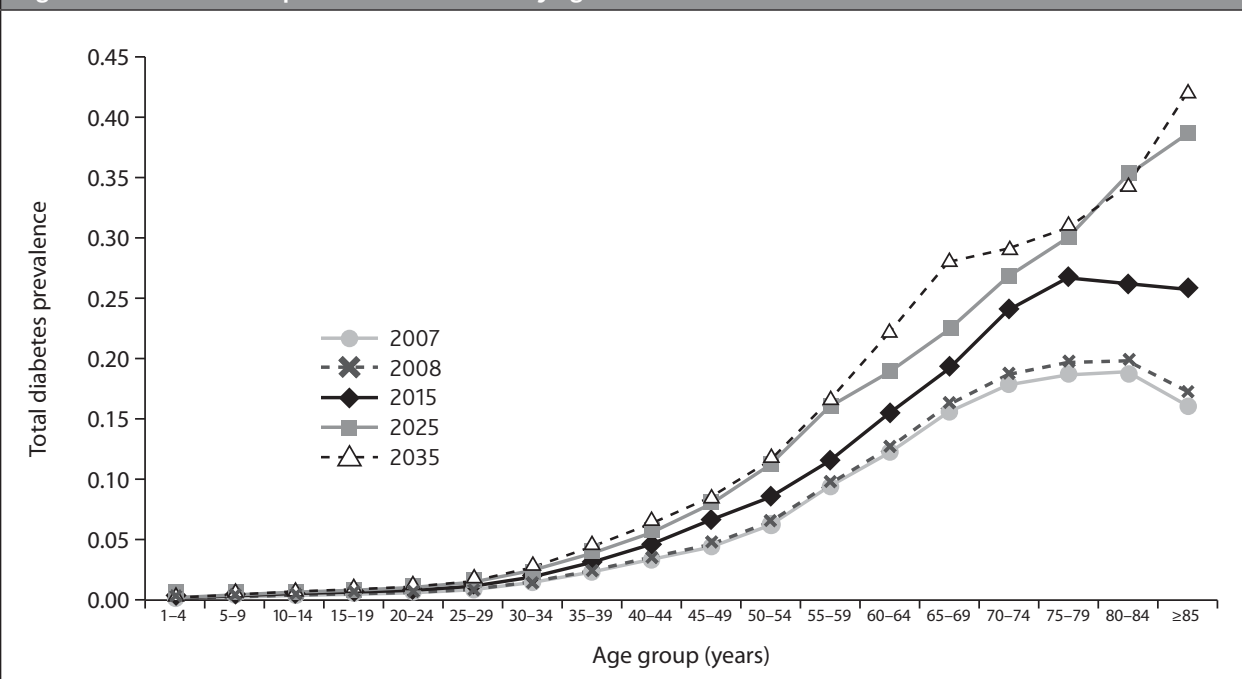


Figure 4. Total diabetes prevalence in Alberta by age band



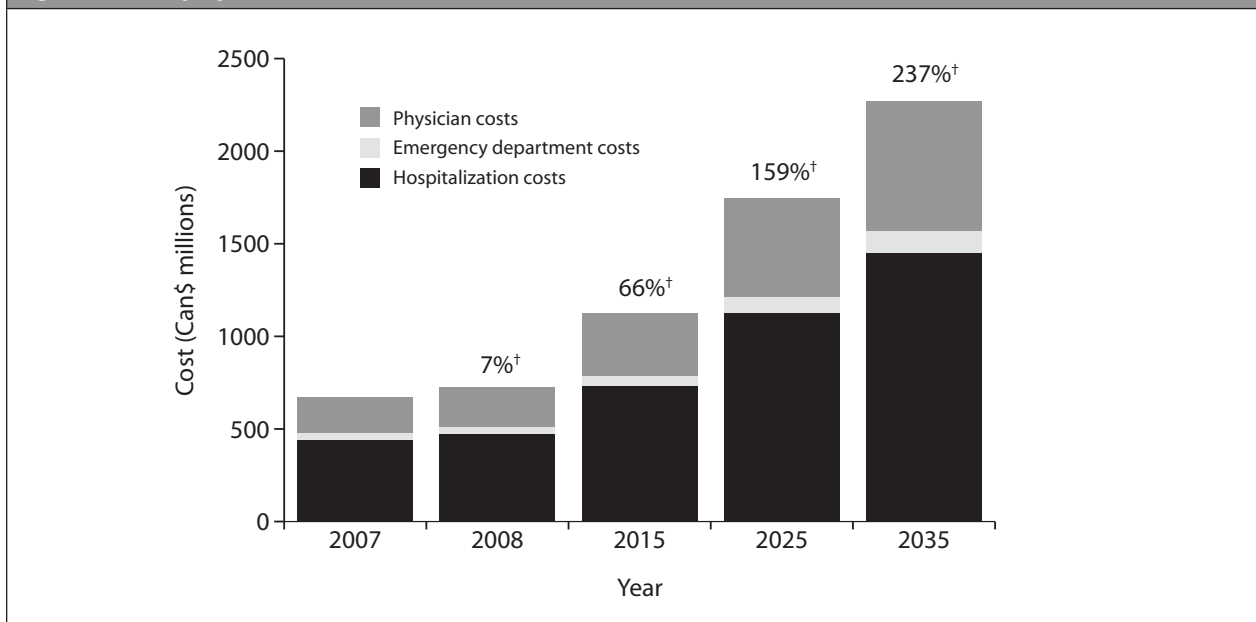
prevalence rates. Age-adjusted and crude prevalence were predicted to increase by 77% and 136% from 2007 to 2035, respectively. Changing demographics will contribute to a 59% increase in diabetes prevalence in the Alberta population.

The change in population structure to older age bands (Table 1, Figure 2) will result in a redistribution of people with diabetes. In the younger age bands (<55 years of age), there are fewer people with diabetes in the scenario that used the 2007 population structure than in the scenario that

applied the 2035 population structure to the 2007 population. In the population >55 years of age, the trend toward older age groups is expected to produce more people (men and women) with diabetes. The significant reduction in mortality rates in all age groups of the diabetes population will also contribute to increasing diabetes prevalence.

Finally, the increasing number of individuals with diabetes (Figure 3) will drive substantial increases in healthcare costs. Total healthcare costs for diabetes in Alberta in 2035

Figure 5. Total projected healthcare costs for diabetes in Alberta*



*2007 Canadian dollars

†Increase from 2007

Table 2. Estimated healthcare costs for treating diabetes in Alberta (\$ millions)*

Costs	2007, \$	2008		2015		2025		2035	
		\$	Increase from 2007, %	\$	Increase from 2007, %	\$	Increase from 2007, %	\$	Increase from 2007, %
Hospitalization	440	473	8	730	66	1125	156	1452	230
Emergency department	34	36	6	56	65	88	159	115	238
Physician	199	214	8	335	68	532	167	705	254
Total healthcare	673	723	7	1121	67	1745	159	2272	238

*2007 Canadian dollars

were predicted to be \$2.27 billion, a 237% increase from 2007 (Table 2, Figure 5). The category with the greatest increase in costs is predicted to be total physician costs, with a rise of 253%, reaching \$700 million in 2035. The category with the greatest proportion of healthcare costs will continue to be hospitalizations, accounting for 65% of total healthcare spending for people with diabetes and costing \$1.45 billion in 2035—a 230% increase from 2007.

DISCUSSION

The ADM suggests that the total number of people in Alberta with diabetes will increase by 248% from 2007 to 2035. Men are predicted to have a higher prevalence and more prevalent cases compared to women in all time periods analyzed. As well, people tended to be diagnosed with diabetes at a younger age (50 to 70 years), so that over time, substantially more people with diabetes will accumulate in the older age bands of 65 to ≥ 85 years. An aging population, increasing incidence and decreasing mortality rates were the

driving forces of increasing prevalence.

We describe the development and initial predictions for diabetes prevalence and healthcare costs in Alberta, using a projection model based on observed historical epidemiologic and healthcare utilization from the same jurisdiction. This approach is different from previous economic forecasting models, which are based on observational data from patients enrolled in randomized, controlled trials (16,17) and driven by the disproven causal associations between glycemic control and clinical outcomes (18,20,21,27-29). The advantage of this approach is that no assumption is made about how mortality benefits are achieved, and the ADM uses data that would be similarly available in other Canadian jurisdictions.

The ADM prevalence estimates are different from those of previously published forecasting models in Canada (12), the United States (11,30) and around the world (8,9). Differences in prevalence projections were expected, to some extent, due to variations in methodology and assumptions regarding input trends. The ADM uses the most recent incidence,

prevalence and mortality data; as a result, it can be expected to provide a reliable prediction of the future burden of diabetes. Although the model predicts prevalence to be higher than previously forecast (8,9,11,30,31), the projections are likely still a conservative estimate of the future burden of diabetes. The model does not capture undiagnosed diabetes, and we assumed an 8 year duration of incidence and mortality trends, after which no further changes were predicted.

Nevertheless, the pattern of growth in diabetes prevalence is consistent with trends seen in Ontario (24), Manitoba (32) and the United States (33). In 2008, the largest increases were projected to be among adults aged 50 to 70 years as they aged through the ADM. By 2035, then, the greatest number of people living with diabetes would be those aged 65 to 80 years. This poses problems for healthcare systems facing an ever-aging population with diabetes.

Estimated increases in healthcare costs from the ADM are higher than previous cost projections for Canada (12) and the United States (34). These differences are also likely due to differences in model assumptions and costing methodology. The ADM shows that the direct medical costs of treating people with diabetes will increase by over 227% by 2035. Estimated healthcare costs are also underestimated in this model, as we did not include all important healthcare products and services, such as medications, dialysis, diabetes education services and other allied healthcare services. These elements will be added in future versions of the model.

Further, we did not include the effects of inflation or an estimate of indirect costs of productivity losses due to morbidity and premature mortality. Estimation of indirect costs is challenging, and while important from a societal perspective, are not directly relevant for decision-making from the perspective of a provincial healthcare system. When indirect costs are included, total cost estimates range from 200% to 400% higher than direct costs alone (35).

Limitations

An economic model is a simplification of aspects of the real world (36), and the act of simplifying results has many limitations, reducing a complex system to include only a few key inputs. The model is based on the following: a) a methodology to identify a diabetes case; b) Alberta population projections; c) increasing diabetes incidence; d) decreasing mortality; e) an 8 year duration of change for incidence and mortality; and f) estimation of healthcare costs (total physician, emergency department and hospitalization) in 2007.

The epidemiologic trends are based on the administrative data case definition, which likely underestimates the true incidence and prevalence of diabetes in the population (22). Nonetheless, this approach to diabetes surveillance is applied in all provinces and territories in Canada (26), increasing the generalizability of the methods. The Alberta population pro-

jections are also based on demographic trends and assumptions that may not be generalizable to other jurisdictions. Within the Alberta population projections, mortality, fertility and migration rates were obtained from 2 sources: the Alberta Healthcare Insurance Plan Stakeholder Registry and Alberta Vital Statistics (23). The factors and trends observed at the time of the population projections were assumed to continue to 2035. However, mortality, fertility and migration rates are influenced by economics, politics and other factors that are likely to change over time.

The projection model assumes that incidence will continue to increase for an additional 8 years (2008 to 2015) and mortality rates will continue to decrease for the same period, based on trends in the preceding decade (1995 to 2007) (22). However, the true duration and trend of future incidence and mortality rate changes in Alberta are unknown and will be affected by many external factors, such as healthcare technology, development of the economy and lifestyle changes. Still, the epidemiology of diabetes with respect to increasing incidence and decreasing mortality observed in ADSS data were also observed in Ontario (24). An 8 year duration of the trends in incidence and mortality is reasonable, as these trends correspond with trends in obesity rates and unhealthy lifestyles (37-40).

Another limitation is the lack of clinical or patient-specific risk behaviours. The ADM treats every individual as equal and does not incorporate data on diabetes risk factors, whether clinical (e.g. A1C, blood pressure, lipids) or lifestyle-related (e.g. body mass index, physical inactivity, diet, smoking, hypertension), and does not take into consideration differing prevalence rates among various ethnic groups. For example, prevalence is higher among First Nations than the general population (41). However, First Nations people were included as part of the full population included in this model. Finally, the projection model does not break down prevalence and costs by health zones in Alberta, which may be useful for policy makers to direct population-level interventions.

CONCLUSION

This study lays the groundwork for an economic forecasting model that will help integrate clinical research to inform policy makers. This work is based on a previous economic model for Canada (12), but incorporates more recent cost and epidemiologic data. Inputs from population-level interventions that reduce diabetes incidence, or policies or treatment interventions that affect healthcare utilization or mortality can be applied to the projection model, and the outcomes and costs of these interventions on the population can be estimated. A cost analysis can be carried out by knowing the population at risk and relative effectiveness of interventions on incidence and mortality rates.

AUTHOR DISCLOSURES

JJ is an Alberta Heritage Foundation for Medical Research Senior Scholar and holds a Canada Research Chair in Diabetes Health Outcomes. This work was supported in part by a grant from Alberta Health and Wellness and a Team Grant to the Alliance for Canadian Health Outcomes Research in Diabetes (ACHORD) (Reference #: OTG-88588), sponsored by the Canadian Institute of Health Research Institute of Nutrition, Metabolism and Diabetes.

AUTHOR CONTRIBUTIONS

All authors were involved in the study design and contributed to the development and critical revision of the manuscript. AO and RL developed the model and analyzed the data. RL drafted the manuscript. Funding was secured by JJ.

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ORIGINAL RESEARCH

Pharmacists' Anticipated Pain Compared to Experienced Pain Associated with Insulin Pen Injection and Fingertip Lancing

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ABSTRACT

OBJECTIVE: There are many barriers to the initiation of insulin therapy in patients with type 2 diabetes, and healthcare provider attitudes may be one factor that can significantly impact patient acceptance. The objective of this study was to determine whether there were differences between pharmacists' anticipated pain associated with insulin pen injection and fingertip lancing vs. their experienced pain during a practical educational session.

METHODS: Pharmacists rated their anticipated and experienced pain using a 10 cm visual analogue scale.

RESULTS: Anticipated pain associated with insulin pen injection was rated significantly higher than experienced pain (N=358; mean/median 4.0/4.0 vs. 1.3/1.0, respectively; $W = -14.325$, $p < 0.001$). Findings were similar for fingertip lancing (N=361; mean/median 3.6/3.0 vs. 1.6/1.0, respectively; $p < 0.001$). Anticipated pain associated with insulin pen injection was rated significantly higher than that of fingertip lancing ($p = 0.01$); however, experienced pain from fingertip lancing was rated higher than that of an insulin pen injection ($p = 0.001$). Experiential learning may be an effective way for healthcare providers involved in diabetes education to gain further knowledge about insulin initiation and eliminate misconceptions, particularly with respect to the use of injection devices. The personal experience gleaned from such practical educational sessions can be applied to interactions with patients in order to address insulin initiation fears.

KEYWORDS: blood glucose monitoring, diabetes, injection, insulin, pain

RÉSUMÉ

OBJECTIF : Il y a de nombreux obstacles à la mise en route de l'insulinothérapie chez les patients atteints de diabète de type 2 et l'attitude des prestataires de soins de santé

pourrait avoir un impact important sur l'acceptation par les patients. L'objet de l'étude était de déterminer s'il y avait des différences entre la douleur que des pharmaciens prévoient ressentir par suite d'une injection d'insuline avec un stylo et d'une piqûre du doigt avec une lancette et la douleur effectivement ressentie au cours d'une séance d'éducation pratique.

MÉTHODES : Des pharmaciens ont évalué la douleur prévue et la douleur ressentie au moyen d'une échelle visuelle analogue de 10 cm.

RÉSULTATS : La valeur de la douleur prévue d'une injection d'insuline avec un stylo a été significativement plus élevée que celle de la douleur ressentie (N = 358; valeur moyenne/médiane : 4,0/4,0 et 1,3/1,0, respectivement; $W = -14,325$; $p < 0,001$). Les résultats ont été semblables pour ce qui est de la douleur causée par une piqûre du doigt avec une lancette (N = 361; valeur moyenne/médiane : 3,6/3,0 et 1,6/1,0, respectivement; $p < 0,001$). La valeur de la douleur prévue a aussi été significativement plus élevée avec l'injection d'insuline avec un stylo qu'avec la piqûre du doigt avec une lancette ($p = 0,01$); toutefois, la valeur de la douleur ressentie avec une piqûre du doigt avec une lancette a été plus élevée que celle de la douleur ressentie avec une injection d'insuline avec un stylo ($p = 0,001$). L'apprentissage expérimental pourrait être une façon efficace pour les prestataires de soins de santé qui éduquent des patients diabétiques d'approfondir leurs connaissances sur la mise en route de l'insulinothérapie et de corriger les idées fausses, surtout en ce qui a trait aux dispositifs d'injection. L'expérience personnelle tirée de séances d'éducation pratiques peut être mise à profit pour dissiper les craintes des patients à l'égard de la mise en route de l'insulinothérapie.

MOTS CLÉS : surveillance de la glycémie, diabète, injection, insuline, douleur

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INTRODUCTION

Despite the availability of newer medications, technologies and knowledge in recent years, many people with diabetes still fail to reach target glycosylated hemoglobin levels (1,2). And yet, evidence shows that improved glycemic control reduces the risk of microvascular complications in both type 1 and type 2 diabetes (3-5). Insulin is currently recommended as one of the antihyperglycemic agents that can enable patients to reach glycemic targets (6), and there is increasing evidence to support the early initiation of insulin therapy in patients with type 2 diabetes, because this approach may help preserve beta-cell function (7,8). In addition, early initiation of insulin therapy has been shown to provide improved treatment satisfaction and quality of life for people with type 2 diabetes (9). Delays in optimal insulin management can greatly affect morbidity and mortality (4,5); such delays are often the result of reluctance on the part of both patients (called *psychological insulin resistance*) and healthcare professionals (called *clinical inertia*) (10-13).

One of the most common patient barriers to initiating insulin is the fear that insulin injections will be painful (12,14,15). But while the anticipated pain associated with insulin injections has been assessed primarily in terms of patient acceptance, anticipated patient pain may affect healthcare professional attitudes as well. Research is needed to explore healthcare professional barriers to the initiation of insulin therapy and develop strategies to overcome them. This study was conducted to explore pharmacists' perceptions and experiences of the pain associated with 2 diabetes-related techniques: insulin pen injection and fingertip lancing for blood glucose (BG) testing.

METHODS

A group of community pharmacists attended a continuing education session on insulin pen injection and BG testing. At the beginning of the session, participants were asked to sign a consent form. They were also asked to rate the pain they anticipated would be associated with insulin pen injection and fingertip lancing for BG testing, using a standardized 10 cm visual analogue scale (VAS). The training session included a didactic portion and a practical segment, which consisted of a self-injection with an empty insulin pen (Autopen24 insulin pen, Sanofi-aventis, Laval, Quebec; BD 5mmx31G needle, Becton-Dickinson, Mississauga, Ontario) and a self-administered BG test (Aviva Nano BG meter Accu-Chek, Laval, Quebec; Multiclix lancing device Accu-Chek, Laval, Quebec).

For the pen injection, pharmacists were instructed to inject into the subcutaneous tissue of the abdomen (with the exception of a 5 cm circle around the navel) or into the upper arm. The needle was to be inserted at a 90° angle to the skin and held in place for 5 seconds after depression

of the plunger to ensure complete simulated delivery of an insulin dose.

For BG testing, pharmacists were instructed to do the following: insert a BG test strip into the meter; poke the side of their finger using the lancing device; gently massage or squeeze the finger to obtain a drop of blood; hold the edge of the test strip to the drop of blood to initiate the test; and wait for the result.

After being trained on the appropriate technique for each procedure, pharmacists completed self-injections and BG testing, including fingertip lancing. They were then asked to rate their pain experience with both procedures, again using a VAS.

Statistical analyses were performed using SPSS version 17 (SPSS; Chicago, Illinois). Anticipated pain and experienced pain were compared using the Wilcoxon signed-ranked test.

RESULTS

In total, 358 pharmacists completed anticipated and experienced pain assessments for the insulin pen injection, and 361 completed assessments for the fingertip lancing. Demographic information was not recorded, but there was a wide range of age and experience, as well as representation from all provinces across Canada. Fewer than 2% of participants had a certified diabetes educator designation.

The anticipated pain of an insulin pen injection was rated significantly higher than experienced pain (N=358; mean/median 4.0/4.0 vs. 1.3/1.0, respectively; $W=-14.325$, $p<0.001$) (Figure 1). Findings were similar for fingertip lancing (N=361; mean/median 3.6/3.0 vs. 1.6/1.0, respectively; $W=-13.468$, $p<0.001$) (Figure 2).

The anticipated pain associated with an insulin pen injection was rated significantly higher than that of fingertip lancing ($W=-2.567$, $p=0.01$) (Figure 3); however, the experienced pain from fingertip lancing was rated higher than that of an insulin pen injection ($W=-3.348$, $p=0.001$) (Figure 4).

DISCUSSION

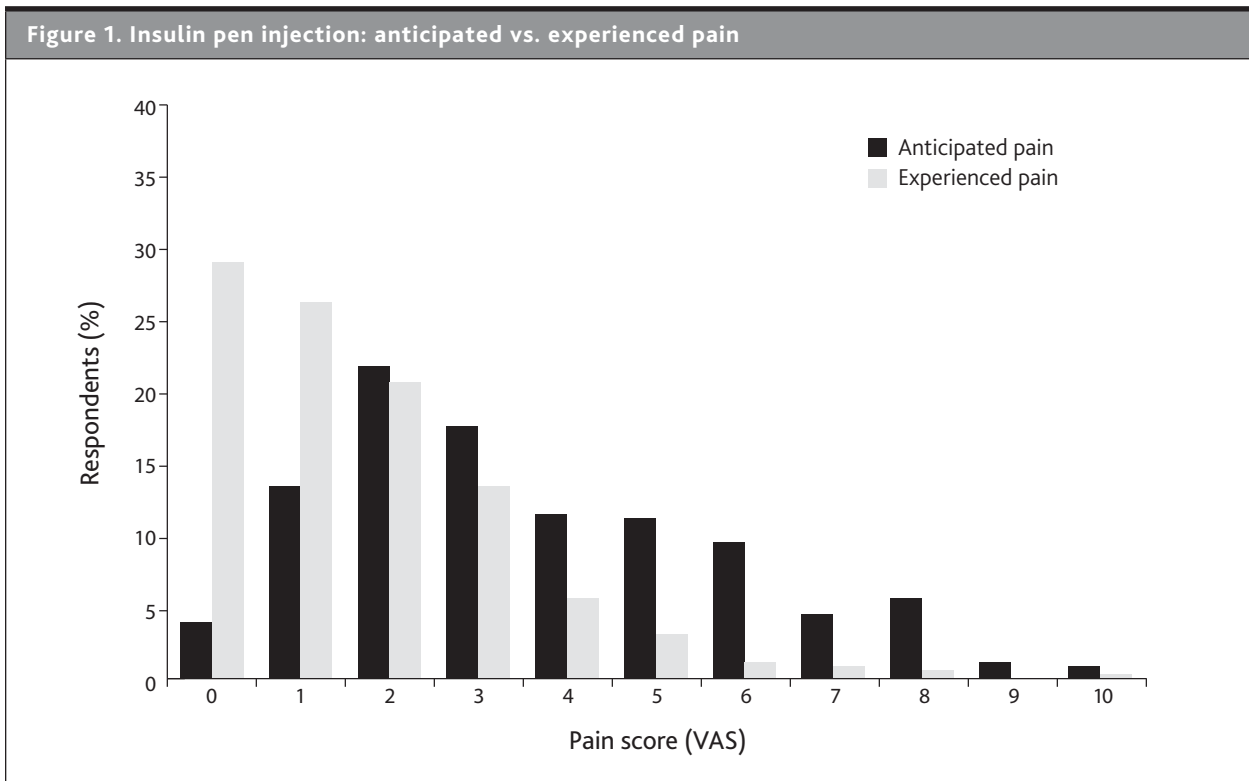
Community pharmacists rated the anticipated pain associated with insulin pen injections and fingertip lancing significantly higher than they rated experienced pain. Insulin injections were generally anticipated to be more painful than fingertip lancing on the VAS (4.0 vs. 3.6, $p=0.01$); however, following both procedures, pharmacists ranked the experienced pain from fingertip lancing as more painful than insulin pen injections (1.6 vs. 1.3, $p=0.001$).

People with diabetes require frequent contact with their healthcare providers. Pharmacists are integral members of the interdisciplinary diabetes healthcare team and in a strategic position to help people understand, manage and use their medications appropriately. Because patients with dia-

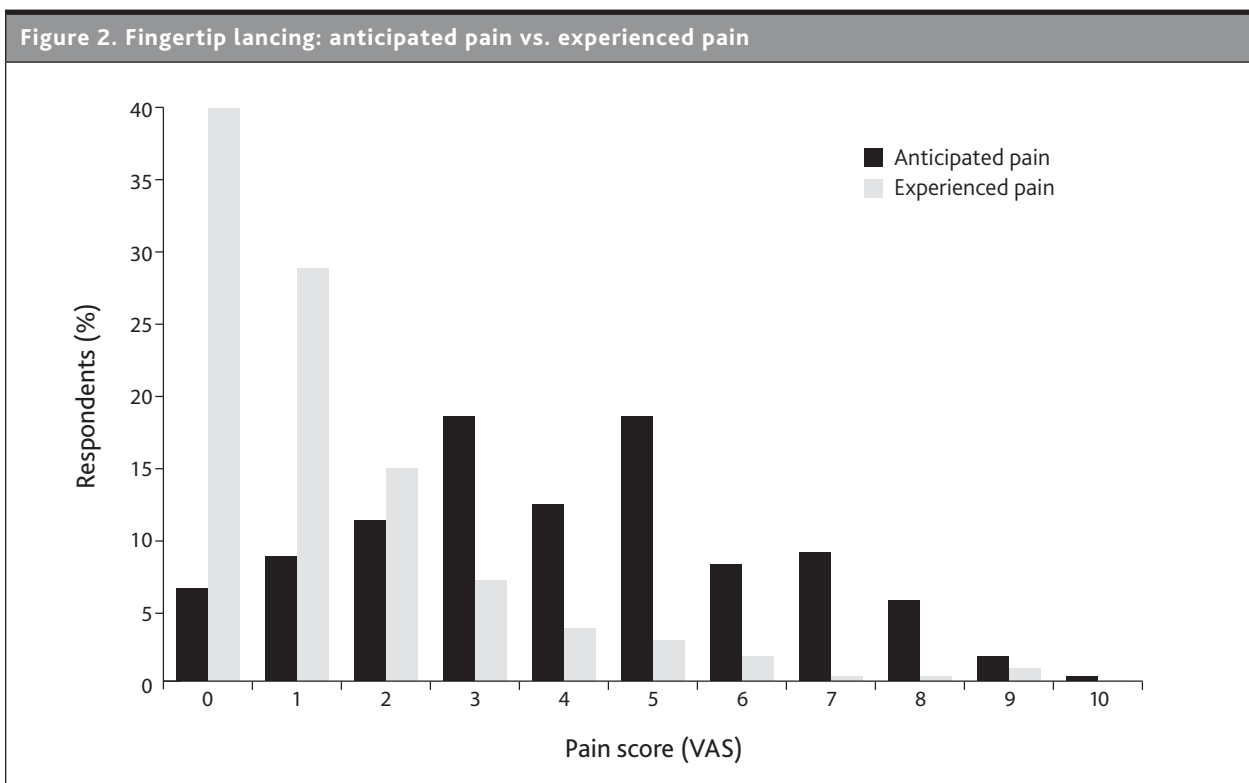
betes interact with their pharmacist 5 to 7 times more than any other healthcare professional (16,17), many pharmacists assume an active role as a medication manager and provide what is now referred to as *medication therapy management* (18,19). As such, they are often responsible for educating

patients on the appropriate administration of insulin; identifying patients who may be candidates for insulin initiation; and in some instances, even initiating insulin therapy as part of a collaborative practice agreement with local physicians.

As insulin is prescribed more and more frequently for



VAS = visual analogue scale

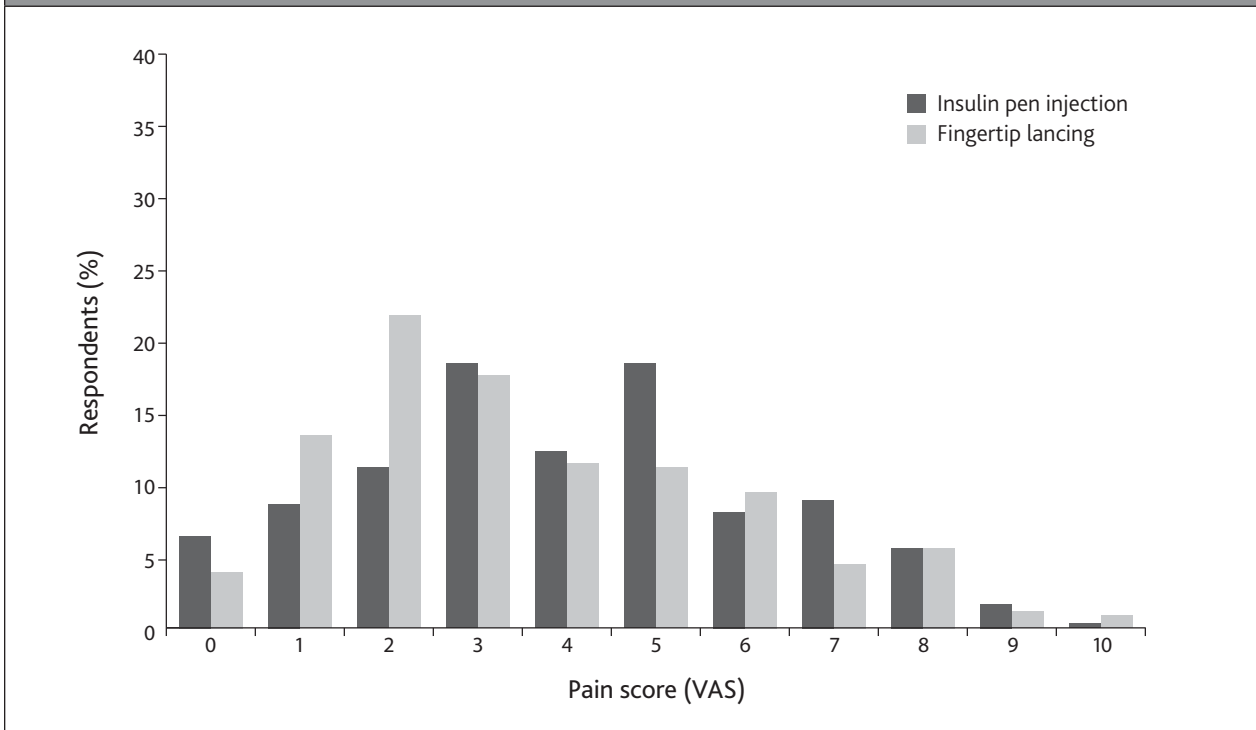


VAS = visual analogue scale

type 2 diabetes, pharmacists are likely spending more time counselling patients on all aspects of its use. Experiential training methods, such as the one used in this study, may help pharmacists better understand patients' concerns about initiating insulin injections. Based on observations from this

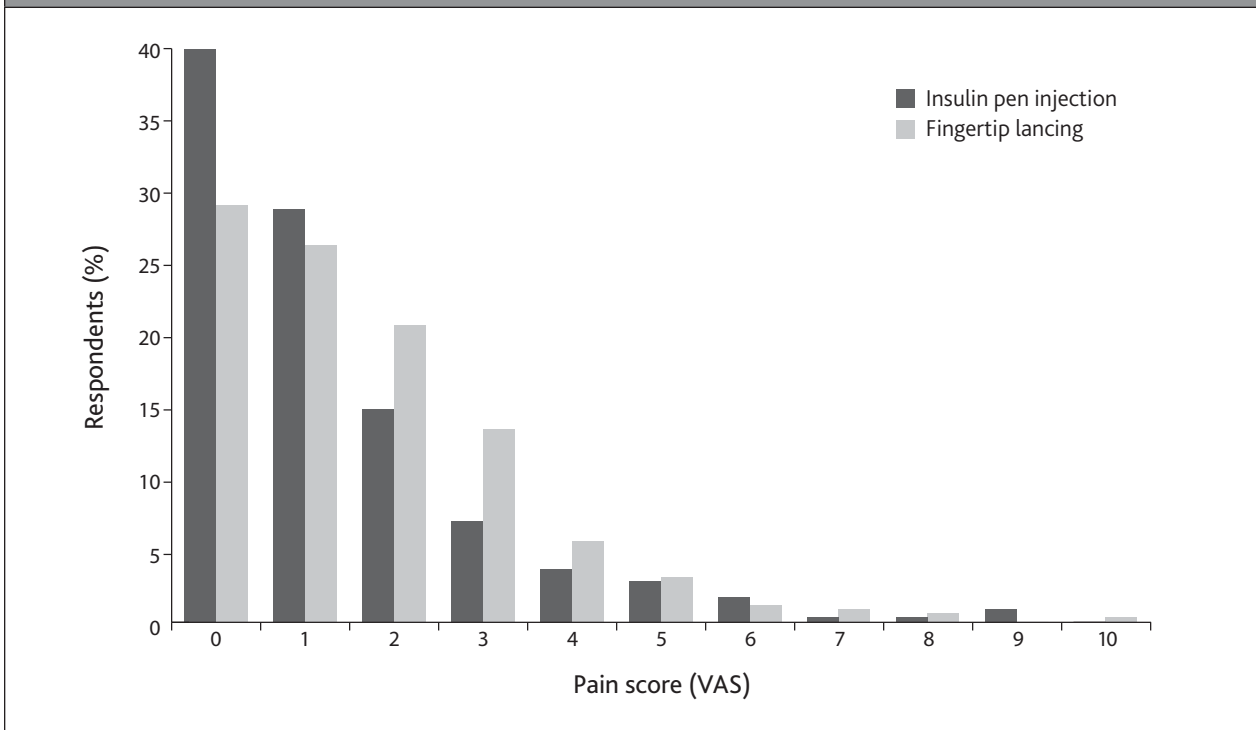
study, pharmacists found insulin injections to be less painful than fingertip lancing for blood glucose testing, an activity that most patients with diabetes have already experienced and even regularly perform by the time of insulin initiation. Further study is needed to determine whether similar train-

Figure 3. Anticipated pain: insulin pen injection vs. fingertip lancing



VAS = visual analogue scale

Figure 4. Experienced pain: insulin pen injection vs. fingertip lancing



VAS = visual analogue scale

ing for physicians and other healthcare professionals might be useful in overcoming clinical inertia.

One of the limitations of this study was the use of a dry injection rather than an injection containing insulin. It is possible that the increased pressure associated with insulin injection may alter the pain sensation, although needle insertion is likely the main cause of pain. As well, pharmacists' previous experience with insulin injections and fingertip lancing was not taken into consideration, and this may have had an impact on their initial scoring or "anticipated pain" on the VAS. One would expect that those who had previously experienced an insulin pen injection would have scored lower, having an understanding that the relative pain associated with injection is low. Finally, baseline characteristics of the pharmacists were not included in the analysis. Further studies are warranted to explore differences in perception based on age, experience, practice location and type of healthcare professional (i.e., physician, diabetes educator, etc).

The anticipated pain associated with insulin injection is a potential barrier to patient acceptance of insulin therapy; however, success with insulin initiation may be improved by better healthcare provider communication (20). Pharmacists should not only discuss the important role of insulin in managing type 2 diabetes, but also address barriers such as fear of injection and anticipated pain. This study identified that pharmacists' anticipated pain associated with insulin pen injections was greater than their experienced pain. In addition, although pharmacists rated the anticipated pain associated with insulin pen injection significantly higher than that of fingertip lancing, their ratings of experienced pain showed that injections were less painful than fingertip lancing. Such misconceptions on the part of healthcare professionals may affect their ability to appropriately counsel patients. All healthcare practitioners involved with insulin initiation should engage in experiential learning in order to improve their effectiveness when educating patients about this important aspect of diabetes management.

AUTHOR DISCLOSURES

Financial support for the drafting of the manuscript was received from BD Diabetes Care.

AUTHOR CONTRIBUTIONS

SD was responsible for the concept and design of the educational session and wrote the manuscript. IM was responsible for the statistical analysis and subsequent revisions.

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ORIGINAL RESEARCH

Development and Pilot-Testing of a Brief Psychosocial Group Intervention Protocol for Type 2 Diabetes Self-Management

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ABSTRACT

OBJECTIVES: To develop a brief psychosocial intervention protocol for type 2 diabetes self-management and pilot-test its implementation.

METHODS: A 6-session evidence-based psychosocial intervention protocol was developed focusing on the role of behaviour modification, maintenance of motivation and emotion management in type 2 diabetes self-management. The intervention was pilot-tested with 15 individuals with type 2 diabetes recruited from participants in the Action to Control Cardiovascular Risk in Diabetes (ACCORD) study.

RESULTS: Repeated-measures analyses of variance of validated psychosocial and behavioural outcome measures revealed that following the intervention, diabetes-related distress and intake of high-fat foods decreased and exercise participation increased. Furthermore, all participants found the intervention to be helpful for diabetes management. The most helpful aspect of the group sessions, derived from inductive classical content analysis of open-ended feedback questionnaires, was the development of friendship and trust in openly sharing experiences with group members.

CONCLUSION: This promising intervention should be further tested using a randomized, controlled trial. The protocol could then be developed as a training manual so that other university-educated professionals could deliver the intervention to people with diabetes, helping to fulfill 1 of the Canadian Diabetes Association's clinical guidelines: providing psychosocial interventions as part of diabetes care.

KEYWORDS: brief intervention, group intervention, knowledge translation, psychosocial, self-management, type 2 diabetes

RÉSUMÉ

OBJECTIF : Élaborer un protocole d'intervention psychologique de courte durée sur l'autogestion du diabète de type 2 et mener une étude pilote sur sa mise en œuvre.

MÉTHODES : On a élaboré un protocole d'intervention psychologique sur l'autogestion du diabète de type 2 fondé sur des données probantes et comportant six séances. Ce protocole est axé sur le rôle de la modification du comportement, du maintien de la motivation et de la gestion des émotions. On a ensuite mené une étude pilote sur la mise en œuvre de l'intervention auprès de 15 personnes atteintes de diabète de type 2 qui avaient participé à l'étude ACCORD (*Action to Control Cardiovascular Risk in Diabetes*).

RÉSULTATS : Des analyses de variance sur plusieurs mesures de critères validés d'évaluation des effets psychosociaux et comportementaux ont révélé qu'après l'intervention, il y avait une réduction de la détresse liée au diabète et de la consommation d'aliments riches en graisses et une augmentation de l'activité physique. De plus, tous les participants ont trouvé l'intervention utile pour la gestion du diabète. L'aspect le plus utile des séances de groupe, selon l'analyse inductive classique de questionnaires à réponses libres, a été la création de liens d'amitié et la possibilité de partager en toute confiance les expériences avec les membres du groupe.

CONCLUSION : Cette intervention prometteuse devrait faire l'objet d'un essai contrôlé et randomisé. Le protocole pourrait ensuite former la base d'un manuel de formation pour que d'autres professionnels ayant un diplôme universitaire puissent utiliser l'intervention auprès de personnes diabétiques, conformément à une des lignes directrices cliniques de l'Association canadienne du diabète : intégrer des interventions psychologiques aux soins du diabète.

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MOTS CLÉS : intervention de courte durée, intervention de groupe, transfert des connaissances, psychosocial, autogestion, diabète de type 2

INTRODUCTION

Self-management training has played an important role in diabetes care since the 1930s (1). Despite the emphasis on self-management in clinical care, adherence to optimal diabetes self-care behaviours remains low. It has been estimated that between 67% and 93% of individuals with type 2 diabetes fail to follow established guidelines for optimal management (2,3). Unfortunately, knowledge of proper diabetes self-care is insufficient for effective management and unrelated to adherence (4).

Researchers and practitioners have become increasingly aware of the important role of psychological and social factors in diabetes self-management (5-7). It is widely recognized that emotional difficulties such as anxiety and depression compromise optimal self-management behaviours (8-10). Even for those who do not experience elevated levels of anxiety and depression, distress over diabetes management is associated with poorer glycemic control (11). In fact, diabetes-specific distress has been shown to compromise glycemic control even after accounting for general emotional distress (11). On the other hand, research has shown that positive changes in diabetes-specific perceptions are associated with increased commitment to diabetes management (12). It is believed that people with diabetes who perceive themselves to be high-functioning from a psychosocial standpoint (e.g. good mental health) may be more motivated to keep up the gruelling and long-term tasks of diabetes management (12).

In light of the important role psychosocial factors play in diabetes self-management, there has been increased awareness of the need to incorporate them into interventions and outcome measures when working with individuals with diabetes (5,6,12). In fact, the 2008 Canadian Diabetes Association (CDA) clinical practice guidelines (13) state that psychosocial factors impact nearly all areas of diabetes self-management. Further, the guidelines recommend that preventive interventions such as psychosocial support be incorporated into primary care.

Recent studies have evaluated self-management interventions that incorporate a psychosocial component (e.g. effective goal setting, assessment of self-efficacy) and have shown promising results (14,15). However, according to a recent Cochrane review (2), only a small number of studies have specifically looked at psychosocial outcomes, and thus more research is required to confirm these results. Furthermore, despite increased recognition of the importance and potential benefits of psychosocial interventions, access to these types of interventions remains an issue (5). Thus, in order to increase access to psychosocial interventions, should

psychosocial management be incorporated into diabetes management, should mental health providers be added to the staff of diabetes centres, or should mental health clinics offer services specifically to those with diabetes?

Given the recommendations in the CDA guidelines (13) (which emphasize the role of psychosocial monitoring and support) and evidence suggesting a lack of access to these types of interventions, the main goal of the current study was to develop a brief psychosocial intervention for type 2 diabetes self-management. A theory-driven/evidence-based 6-session psychosocial group intervention protocol was developed by a team of psychologists and psychology graduate students. The intervention's contents were developed using a cognitive behavioural framework (16), the transtheoretical model of change (17,18) and principles of motivational interviewing (19), and incorporated a focus on the role of behaviour modification, maintenance of motivation and emotion management in type 2 diabetes self-management. The intent was to develop a protocol that could be implemented by diabetes professionals with minimal support from psychological services. In this way, the reach of the intervention could be maximized.

An additional goal of the current study was to pilot test the implementation of this brief intervention. Outcome measures collected during pilot testing included validated psychosocial and behavioural measures, in order to assess the impact of the intervention on psychosocial functioning and diabetes-specific self-care behaviours, as well as open-ended questionnaires to assess participants' qualitative experiences.

METHODS

Participants

A convenience sample consisting of individuals with type 2 diabetes who were involved in the Action to Control Cardiovascular Risks in Diabetes (ACCORD) study (20) in Halifax, Nova Scotia, Canada, was recruited for the current study. One of the goals of the ACCORD randomized clinical trial was to evaluate whether a therapeutic strategy targeting a glycated hemoglobin (A1C) level of <6.0%, using a treat-to-target approach, would reduce the rate of cardiovascular disease. ACCORD participants were randomized to either attempt to achieve these lower levels or attempt to maintain A1C levels between 7.0% and 7.9%. ACCORD participants were specifically recruited for the current study because they had already received intensive personalized clinical attention for several years as part of the study protocol (the ACCORD study was nearing completion at the time of the current study) and had been given a number of tools (e.g. glucose-lowering medication and diet and lifestyle counselling) to achieve their goals. However, because the goals of the ACCORD trial were ambitious, it was expected that psychosocial factors might be particularly relevant for

this group. As well, given the long-standing relationships between these individuals and the diabetes research staff, any benefit from general social support would have been accomplished already. As such, any outstanding psychosocial issues would not likely have been responsive to general social support.

Inclusion and exclusion criteria for the ACCORD study are described elsewhere (20,21). In Nova Scotia, 81 ACCORD study participants were recruited for the current study. Of these, 16 participants attended at least 1 of the 6 group sessions. Participants in the current study were from both arms of the ACCORD study and had been part of the study for 3 to 5 years. One participant who completed the questionnaires incorrectly was excluded from analyses. Thus, 12 men and 3 women, with an age range of 59 to 78 years and a mean (SD) age of 66 (6.2) years, were included in the current study. Forty-six percent had community college or higher education, all but 1 (a widower) were married and all but 1 self-identified as white. Two participants dropped out of the study after the first session: 1 cited the high cost of travelling to sessions and parking as her reason for not continuing, and the other cited that he saw few benefits to attending the group. Of the remaining participants, 6 attended all 6 sessions, 3 attended 5 sessions, and 4 attended 4 sessions.

Procedure

The intervention consisted of 6 sessions, each lasting 2 hours. Each group consisted of 3 to 8 participants and 2 facilitators, who were clinical psychology doctoral students or post-doctoral fellows, working under the supervision of a registered health psychologist with expertise in diabetes. Sessions were interactive and patient-centred and consisted of both educational and problem-solving components. Each session dealt with a psychosocial topic relevant to diabetes self-management, with each week building on what had been discussed the previous week. A brief 2-page handout consisting of relevant information and written exercises was provided at each session. Participants completed all outcome measures at the beginning of the first session (pre), at the end of the last session (post) and 3 months after the last session (follow-up).

Intervention content

Session 1 began with group introductions, an explanation of the intervention structure and a few basic rules (e.g. confidentiality, respect). This session focused on setting and managing behavioural goals using goal-setting principles such as SMART (i.e. specific, measurable, achievable, relevant, timely) and building flexibility into the process. The importance of monitoring and rewarding behaviours over outcomes was also highlighted.

Session 2 focused on maintaining motivation in diabetes self-care. Participants learned the difference between short-term motivation (e.g. negative emotions) and long-term motivation (e.g. positive emotions, self-identity). They completed a decisional balance for a desired diabetes self-care behaviour (e.g. a specific exercise or eating goal) and identified and problem-solved potential barriers to self-care behaviours.

Session 3 focused on stress management in diabetes self-care. Participants learned the difference between stressors as situations and stress as individual responses. They also learned about the physiological effects of stress, and the ways stress impacts a person's ability to engage in proper diabetes self-care. They learned the difference between self-focused and problem-focused stress-management strategies. Finally, participants were encouraged to develop a plan to manage stressful situations in their own lives.

Session 4 focused on emotion management in the face of ongoing diabetes care. First, the group discussed how difficulties managing emotions can affect adherence to treatment demands (e.g. decreases motivation to exercise, eat healthfully). The cognitive behavioural model was introduced, including some distorted or unhelpful thinking styles, and how these relate to emotions and behaviours. Finally, participants practiced identifying and challenging distorted or unhelpful thinking.

Session 5 focused on overcoming emotional eating. First, emotional eating was normalized, and the reinforcements certain foods provide (e.g. distraction; release of reward-related chemicals, such as dopamine) were explained. Next, participants were encouraged to identify their own triggers (e.g. boredom, sadness, anxiety) and problem-solve alternatives to emotional eating.

Session 6 consisted of a review of material covered over the previous 5 sessions and a discussion about long-term strategies for successful diabetes care. Participants were encouraged to develop strategies for staying on course and remaining accountable after group termination. A more detailed description of the sessions' contents can be obtained from the authors upon request.

Measures

The Diabetes Distress Scale (DDS) (22) is a 17-item self-report scale that assesses diabetes-related emotional distress. The DDS is divided into 4 subscales: emotional burden (e.g. "feeling overwhelmed by the demands of living with diabetes"); physician-related distress (e.g. "feeling that my doctor doesn't take my concerns seriously enough"); regimen-related distress (e.g. "feeling that I am often failing with my diabetes regimen"); and diabetes-related interpersonal distress ("feeling that my friends/family don't appreciate how difficult living with diabetes can be"). Each item is rated on

a Likert scale, with values ranging from 1 (no problem) to 6 (serious problem). The range of possible values for each subscale was 5 to 30 for emotional burden, 4 to 24 for physician-related distress, 5 to 30 for regimen-related distress and 3 to 18 for diabetes-related interpersonal distress. The DDS has been used in both research and clinical practice (23). It has been shown to have high internal consistency, with a Chronbach's alpha of 0.93 (22), and good concurrent validity, showing positive correlations with depressive symptomatology, poorer adherence to meal planning recommendations and lower levels of exercise (22).

The Center for Epidemiologic Studies Depression (CES-D) Scale (24) is a widely used 20-item self-report scale designed to measure depressive symptomatology over the preceding week in the general population. Items are rated on a Likert scale ranging from 0 (rarely or none of the time; less than 1 day) to 3 (most or all of the time; 5 to 7 days). Scores range from 0 to 60, with higher scores indicating higher levels of depressive symptoms. Scores above 16 have been found to differentiate between depressed and non-depressed individuals in a community sample (25). The CES-D scale has been found to have very high internal consistency and good validity as demonstrated by significant correlations with clinical ratings of depression (24).

The Satisfaction with Life Scale (SWLS) (26) is a 5-item self-report questionnaire developed to measure global life satisfaction. Participants are asked to rate items (e.g. in most ways, my life is close to my ideal) on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The SWLS was shown to have favourable psychometric properties, including high internal consistency and high temporal reliability. Further, scores on the SWLS correlate moderately to highly with other measures of subjective well-being (26).

The Summary of Diabetes Self-Care Activities (SDSCA) scale (27) is a brief self-report questionnaire that assesses adherence to the following areas of diabetes self-care: diet, exercise, blood-glucose testing, foot care and smoking. The SDSCA has been shown to be internally consistent and correlate positively with other measures specifically assessing particular areas of self-care, demonstrating good concurrent validity (27).

Finally, at the end of the last session, participants completed a feedback questionnaire consisting of 4 open-ended questions that inquired about their subjective experiences of the intervention. Questions were 1) What did you find most helpful about attending the group? 2) What did you find least helpful about attending the group? 3) What changes would you suggest for future groups? 4) Did the group help you in your diabetes management? If yes, please explain how. If not, was there anything that you felt might have helped you, but that was not addressed in the group?

Using SPSS 15.0 (SPSS Inc., Chicago, Illinois), a series of repeated-measures analyses of variance were performed on the validated psychosocial and behavioural outcome measures to assess changes in outcome measures between pre, post and follow-up. Although the small convenience sample of this study resulted in low power to detect significant differences, a few important significant and marginally significant outcomes were found. These were followed up with planned pre/post and pre/follow-up comparisons. Effect sizes are reported as partial eta² (η_p^2), which describes the proportion of total variance that is accounted for by the effect in question. Intent-to-treat analyses were conducted using a conservative last-value carried-forward method for replacing missing values from the 2 participants who did not complete the post and follow-up measures.

Ethical review

The current study was approved by the Capital Health Authority research ethics board in Halifax, Nova Scotia, Canada.

RESULTS

Psychosocial outcomes

Table 1 shows results for psychosocial outcome measures in the current study. Results reveal an overall effect of time for the emotional burden subscale of the DDS ($F[2,28]=4.43$, $p=0.021$, $\eta_p^2=0.24$). However, none of the planned comparisons (i.e. pre/post and pre/follow-up) were significant. For the regimen-related distress subscale of the DDS, the assumption of sphericity was violated ($\chi^2[2]=6.75$, $p=0.034$); therefore, multivariate tests are reported (28). There was a

Table 1. Psychosocial outcome measures

Psychosocial scale	Pre	Post	Follow-up
Diabetes Distress Scale			
Emotional burden	9.53 (3.76)	11.73 (5.67)	8.73 (3.41)
Physician-related distress	5.69 (3.26)	7.42 (3.21)	6.17 (2.82)
Regimen-related distress	10.87 (4.34)*	10.88 (4.91)	9.02 (2.99)*
Diabetes-related interpersonal distress	6.33 (3.35)	6.85 (4.39)	5.33 (2.53)
Center for Epidemiologic Studies Depression Scale	11.72 (7.30)	9.80 (7.37)	9.96 (9.71)
Satisfaction with Life Scale	24.36 (8.06)	25.43 (7.29)	26.29 (7.88)

Data are mean (SD)

*Significantly different at $p<0.05$

marginally significant effect of time ($F[2,13]=3.64$, $p=0.056$, $\eta_p^2=0.36$). Follow-up analyses reveal there was no difference between pre and post ($F<1$), but participants reported a significant decrease in regimen-related distress between the pre and follow-up assessments ($F[1,14]=6.78$, $p=0.02$, $\eta_p^2=0.33$). There were no significant differences in the physician-related distress subscale ($F[2,28]=2.09$, $p>0.05$, $\eta_p^2=0.13$) or diabetes-related interpersonal distress subscale ($F[2,28]=2.21$, $p>0.05$, $\eta_p^2=0.14$). No significant differences were found for the CES-D ($F[2,28]=1.07$, $p>0.05$, $\eta_p^2=0.07$) or SWLS ($F[2,28] <1$).

Behavioural outcomes

Even before beginning the group sessions, participants reported high adherence rates to behaviours other than those involving diet and exercise. They reported testing their blood glucose an average of 6.85 of the preceding 7 days and engaging in foot care an average of 6.20 of the preceding 7 days. Also, all participants reported taking their recommended diabetes medication on all of the preceding 7 days. All but 2 participants had not smoked a cigarette in at least 2 years. One smoked an average of 1 cigarette per day, and the other an average of 37 cigarettes per day. Neither participant changed his/her smoking behaviour following the intervention. Because participants were highly adherent to self-care behaviours other than diet and exercise before beginning the intervention, and because diet and exercise are the most difficult to adhere to (3), only these factors were analyzed in the current study. Results are shown in Table 2.

There was a marginally significant effect of time for avoidance of high fat foods ($F[2,26]=2.72$, $p=0.084$, $\eta_p^2=0.17$). Follow-up analyses revealed that participants decreased intake of high-fat foods between pre and post ($F[1,13]=7.83$, $p=0.015$, $\eta_p^2=0.38$). However, this change was not fully sustained at follow-up as demonstrated by a nonsignificant increase in avoidance from pre to follow-up ($F[1,13]=1.78$, $p>0.05$, $\eta_p^2=0.12$). Participants also increased the number of days that they participated in specific exercise sessions, over and above household chores or work activities over the

preceding week. As the assumption of sphericity was violated ($\chi^2[2]=8.23$, $p=0.016$), multivariate tests are reported (28), revealing an overall marginally significant effect of time ($F[2,13]=3.78$, $p=0.051$, $\eta_p^2=0.37$). Participants increased exercise between pre and post ($F[1,14]=6.79$, $p=0.021$, $\eta_p^2=0.33$). Again, however, this increase was not fully sustained at follow-up, as demonstrated by a nonsignificant increase from pre to follow-up ($F[1,14]<1$, $p>0.05$). No other item on the DSC indicating adherence to diet and exercise changed significantly.

In addition to the quantitative measures, feedback from the 12 participants who completed the 4-item open-ended questionnaire was very positive. All participants expressed that the group sessions were helpful for their diabetes self-management. Responses to Question 1 and the first part of Question 4 were combined to determine helpful or positive aspects of the group sessions. Similarly, responses to Questions 2 and 3, as well as the latter part of Question 4, were combined to determine aspects of the group sessions participants found least helpful or would change.

Responses were coded using an inductive (i.e. codes emerging from the data) classical content analysis (i.e. each code is subjected to a frequency count) (29). Themes were identified by the 1st author and discussed with the 3rd author. Next, the 1st and 3rd authors independently coded all responses. A Cohen's kappa (30) of 0.77 was obtained for the most helpful aspects of the group sessions, and of 0.93 for the least helpful aspects, demonstrating a high level of agreement between the 2 authors (31). Discrepancies were discussed until consensus was reached between both authors on the final coding of participants' responses.

Analysis of aspects of the group sessions participants found most helpful revealed 5 themes, which are presented in Table 3. The majority of participants found that working together in an open, friendly and respectful group atmosphere was helpful. One participant described that "Although individuals, we all got along and discussed whatever we felt of concern. No one was put down or made to feel insignificant." One participant called it "friendship," and another "the togetherness feeling." Only 3 of the 12

Table 2. Behavioural outcomes

Summary of Diabetes Self-Care Activities	Pre	Post	Follow-up
Last 7 days healthful eating plan	4.93 (1.28)	5.60 (1.18)	4.87 (1.69)
Past month healthful eating plan	5.13 (1.25)	5.47 (1.06)	5.40 (1.06)
Last 7 days fruits and vegetables	5.21 (1.97)	5.73 (1.58)	5.33 (1.76)
Last 7 days avoid high-fat foods (meat/dairy)	3.86 (1.46)*	4.67 (1.17)*	4.43 (1.56)
Last 7 days 30 minutes physical activity	3.80 (2.08)	4.27 (2.28)	4.33 (2.44)
Last 7 days specific exercise session [†]	3.27 (2.02)*	4.20 (2.04)*	3.67 (2.44)

Data are mean (SD)

*Significantly different at $p<0.05$

[†]A specific exercise session (e.g. swimming, walking) other than what one does around the house or as part of one's work

Table 3. Results of inductive classical content analysis of responses to open-ended questions

Theme*	Count
Aspects of groups most positive/helpful	
Friendship/respect/openness/togetherness	8
Information from other group members	6
Shared experience/all in same boat	4
Information and encouragement from facilitators	3
Increased self-awareness	5
Aspects of groups least helpful or to change	
Larger/more varied groups	5
Follow-up meetings	2
More input from participants	1
More answers regarding long-term	1

*Themes presented in order of endorsed by most to least number of participants

participants specifically mentioned the facilitators as being a helpful aspect of the group. Aspects of the group sessions participants found least helpful or would change for future groups are also presented in Table 3. Five participants mentioned that larger or more varied groups would be helpful (2 of these were in a 3-member group). Two participants mentioned that follow-up groups would be helpful.

DISCUSSION

The aims of this study were to develop and pilot-test a brief psychosocial group intervention for type 2 diabetes self-management. The intervention was well received by participants, who all found it helpful in managing their diabetes. Although the intervention consisted of only 6 sessions, many participants commented that they had developed a sense of friendship and togetherness with other group members and that they felt very comfortable and respected when discussing challenges they face in managing type 2 diabetes.

At the 3-month follow-up, participants had experienced a decrease in distress over their diabetes regimen from pre-intervention levels. This result is particularly promising, as it has been shown that decreasing diabetes-specific distress is associated with improved glycemic control (12). Participants also decreased their intake of high-fat food and increased their level of exercise, although these behaviour changes were not fully sustained at the 3-month follow-up. It is not possible to know exactly why these behaviour changes were not sustained, although it is well known that health behaviours such as exercise or diet are difficult to maintain (32). Many participants noted that knowing they would be accountable to other participants and facilitators each week with regards to their behaviour goal helped with motivation.

As discussed below, follow-up meetings or a more tailored discussion on relapse prevention, with an emphasis on finding others in their lives to help them stay accountable, might have been helpful for participants to maintain the positive changes they had undertaken.

There were no significant changes in levels of depression (CES-D) or satisfaction with life (SWLS) scores. In terms of the CES-D, even before the intervention began, participants' scores were well below the proposed threshold for clinically significant depression (i.e. a CES-D score of 16). For the SWLS, scores can be interpreted in terms of absolute values, with scores between 21 and 25 representing "slightly satisfied" and scores between 26 and 30 representing "extremely satisfied" with life (33). In the present study, participants' scores moved from the "slightly satisfied" to "extremely satisfied" range from the beginning of the intervention to the 3-month follow-up. Thus, although participants demonstrated high levels of psychosocial functioning at the beginning of the intervention, which might have precluded significant changes from occurring, small changes in both of these measures might nonetheless suggest a slight increase in general psychological well-being.

A few modifications to the current intervention could be incorporated for future groups. First, some participants expressed a desire for follow-up sessions. One or more follow-up sessions could be incorporated, either as group meetings or in the form of "check-in" phone calls from facilitators several months after the group intervention. Alternatively, or in addition, sessions could be offered at 2 to 4 week intervals rather than weekly. An equal number of sessions over a longer time period might provide more opportunities for participants to incorporate the skills acquired during sessions into their daily lives and share their new experiences and challenges with group members and facilitators. These modifications might increase the likelihood that participants will maintain the positive behaviour changes they undertook during the intervention. Also, future groups should aim to have a minimum of 4 participants and, to plan for attrition, at least 6 participants for the initial session. In addition, more diverse groups (e.g. with respect to sex, age) might prevent groups from becoming overly social at the expense of focusing on session content. Finally, more in-depth exit interviews and on-going qualitative feedback from participants would be helpful in continuing to develop the intervention.

The last session on managing long-term goals and motivation could provide more focus on personalizing participants' strategies for long-term behaviour change and preventing relapse into old unhealthy habits, modelled on Marlatt and colleagues' work on relapse prevention (34). For example, group members could identify their own high-risk situations and emotions (e.g. social gatherings, negative emotional

states) and actively problem solve these using techniques borrowed from evidence-based relapse prevention interventions (e.g. generating alternatives and consequences of actions, behavioural rehearsal) (35).

Finally, several participants raised travel time and cost as negative aspects of attending group sessions. Group facilitators could coordinate with other healthcare practitioners (e.g. nurses, dietitians) who could offer other medical services either directly prior to or following group sessions to address this potential barrier.

The current study pilot-tested the intervention protocol on a small convenience sample. ACCORD participants may not be representative of all individuals with type 2 diabetes, as they were already participating in a long-term study on diabetes management. In the future, a randomized controlled trial using a larger, representative sample of people with type 2 diabetes should be conducted to determine whether the intervention results in better outcomes than treatment as usual.

The value of the current intervention's structure as a week-by-week, structured protocol lies in the ease with which the intervention could become widely accessible. That is, the intervention developed for this paper would become a training manual, such that other healthcare practitioners (e.g. nurses, social workers), or even university-educated individuals interested in healthcare, could be trained in delivering the intervention. This type of manual-based, structured brief intervention provides a unique and valuable tool to meet the CDA guidelines related to increasing access to psychosocial assessments and interventions. There is a clear and urgent need for such a protocol, given that lack of access to psychosocial interventions has been highlighted as an issue in diabetes care (5).

In conclusion, the current study demonstrated that a brief, 6-session psychosocial group intervention holds much promise for individuals with diabetes. As the intervention resulted in decreases in diabetes-specific distress and improvements in self-care behaviours, it can become an important tool for healthcare professionals to use in helping patients better manage their diabetes for long-term health.

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AUTHOR DISCLOSURES

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AUTHOR CONTRIBUTIONS

All of the authors were actively involved in the development of the intervention's protocol. BS was primarily responsible for data analyses, preparation of the manuscript and its submission; with critical input and approval of the final version of the manuscript by MV and SC. BS and SC acted as intervention facilitators under the supervision of MV.

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ADDENDA

2nd National Obesity Summit abstracts. *Can J Diab.* 2011;35:137-218.

In the print version of the abstracts listed above, poster presentation 294 was omitted.

294

Macrophages attract other immune cells in response to obesogenic environment

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Childhood obesity is a global epidemic, and there is urgent need to understand its underlying mechanisms. It has been recognized that obesity is associated with chronic low-grade inflammation that leads to insulin resistance in many obese subjects. It has been demonstrated that macrophage accumulation in adipose tissue in obesity is a major source of inflammatory cytokines that lead to insulin resistance. It has been suggested that adipocytes are the cells responsible for secretion of chemokines that attract these macrophages, and that these cells then secrete inflammatory cytokines that exacerbate insulin resistance leading to the vicious cycle of inflammation seen in obesity. It is unclear if macrophages themselves produce factors that affect immune cell-immune cell crosstalk in obesogenic environment. This work was conducted to determine if exposure of macrophages to obesogenic environment leads to macrophage activation, immune cell attraction, and to characterize the pathways and molecules in activated macrophages in response to this environment.

Primary rat peritoneal macrophage treatment with palmitate, one of the most abundant saturated fatty acids in western diet and a known inducer of inflammatory responses, resulted in production of factors that attracted macrophages, and stimulated the migration of neutrophils. Furthermore, we noted phosphorylation of inflammatory pathways (JNK, p38 MAPK) and upregulation of gene expression of pro-inflammatory cytokines (IL-6, TNF α) and chemokines (KC, MCP-1). Analysis of palmitate-treated macrophage secretome revealed multiple cytokines and chemokines, with some being potential candidates for the observed macrophage and neutrophil chemoattraction. In conclusion, Exposure of macrophages to obesogenic environment resulted in secretion of cytokines and chemokines that attracted macrophages and neutrophils, activation of inflammatory pathways, and upregulation of cytokine and chemokine gene expression.

ERRATA

Latter C, McLean-Veysey P, Dunbar P, et al. Self-Monitoring of blood glucose: what are healthcare professionals recommending? *Can J Diab.* 2011;35:31-38.

In the print version of the article listed above, an interviewee made reference to a "Pharmacy Practice" journal in Table 3. The article offered www.pharmacypractice.org in reference to a Pharmacy Practice journal. It has come to attention that the interviewee may have been referring to the Canadian journal "Pharmacy Practice," whose URL is www.CanadianHealthcareNetwork.ca. We regret any inconvenience to our readers.