

Lifestyle interventions for type 2 diabetes

Relevance for clinical practice

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ABSTRACT

OBJECTIVE To review evidence from literature on type 2 diabetes pertinent to physical activity and diet and lifestyle modification, and to determine the relevance of this evidence to clinical practice.

QUALITY OF EVIDENCE Direct (level I) evidence supports interventions for physical activity and diet modification for primary prevention and management of type 2 diabetes. Few studies examine the effectiveness of primary health care providers' making such interventions.

MAIN MESSAGE Family physicians have an important role in identifying people at risk of developing type 2 diabetes and managing those diagnosed with the disease, yet they struggle to deliver practice-based interventions that promote sustainable behaviour change among their patients.

CONCLUSION It is evident that supporting patients to make changes in their physical activity and dietary habits can prevent onset of type 2 diabetes. Translating this finding into effective recommendations for clinical practice requires further effort and evaluation.

RÉSUMÉ

OBJECTIF Relever les données de la littérature concernant l'effet de l'activité physique et des modifications au mode de vie et aux habitudes alimentaires sur le diabète de type 2 (DT2) et déterminer la pertinence de ces observations pour le clinicien.

QUALITÉ DES PREUVES Il existe des preuves directes (de niveau I) démontrant l'efficacité de l'exercice et d'un changement des habitudes alimentaires pour la prévention primaire et le traitement du DT2. Peu d'études portent sur l'efficacité des interventions des intervenants de première ligne en ce sens.

PRINCIPAL MESSAGE Le médecin de famille joue un rôle primordial pour identifier les personnes susceptibles de développer un DT2 et pour traiter les patients atteints; dans sa pratique, toutefois, il arrive mal à susciter des changements comportementaux durables chez ses patients.

CONCLUSION Il est bien établi que la promotion des l'exercice et des modifications dans les habitudes alimentaires peut prévenir l'apparition du DT2. Il faudra toutefois davantage d'efforts et d'évaluations avant que ces données puissent se traduire en recommandations efficaces pour le clinicien.

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Cet article a fait l'objet d'une évaluation externe.

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Worldwide, the incidence of type 2 diabetes is reaching epidemic proportions. More than two million Canadians are estimated to have diabetes; most cases are classified as type 2.¹ The economic burden of diabetes and its related complications is estimated at between \$4 and \$5 billion (US) a year in Canada.² Whether diagnosed or undiagnosed, type 2 diabetes is recognized as a strong risk factor for cardiovascular disease and for associated complications that result in substantial morbidity and mortality.^{3,4}

Onset of type 2 diabetes results from a complex interaction between genetic and environmental factors that have been researched extensively. The natural history for people at risk of developing type 2 diabetes is weight gain and deterioration in glucose tolerance.⁵ A startling rise in the prevalence of obesity and a more sedentary or westernized lifestyle have changed the profile of type 2 diabetes. It is no longer considered a geriatric disease, but is increasingly associated with onset at a younger age, particularly in high-risk ethnic groups.^{6,8}

Family physicians identify diabetes as one of the most common chronic diseases managed in primary health care.^{9,10} Most patients diagnosed with type 2 diabetes are cared for by their family physicians—scheduling office visits up to 9 times yearly, mainly for diabetes care.¹¹ Patient self-management, pharmacology, and appropriate lifestyle choice has long been the focus of type 2 diabetes literature, with modification of physical activity and diet as the cornerstones of disease management. Family physicians have an important role in promoting healthy lifestyle change to type 2 diabetes patients but have identified this role as challenging.¹²⁻¹⁴

The literature describes an array of services and programs that target change in lifestyle behaviour;

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although integration and evaluation of such interventions delivered at the primary level remains “limited and piecemeal.”¹⁵ Efficacy research has been described as examining interventions under optimal conditions, and results of such studies might not generalize to real-world settings having less motivated patients, busy physicians, and scarce resources¹⁶ that are typical of many family practices in Canada. This paper aimed to review the evidence identifying physical activity and diet as key areas for intervention in primary prevention and management of type 2 diabetes. As well, we examined lifestyle modification strategies, tools, and resources that have proved effective in primary health care.

Quality of evidence

Computerized databases were searched for English-language articles only from January 1980 to December 2001: MEDLINE, CINAHL, EMBASE, and all databases within *The Cochrane Library*. Key words included type 2 diabetes (and related MeSH terms, such as diabetes mellitus and non-insulin-dependent), terms related to physical activity and diet (eg, exercise and nutrition), obesity, and primary health care practice. Bibliographies of selected studies and relevant references were also obtained. Experts from the Type 2 Diabetes Education Committee (TDEC), key informants within diabetes and lifestyle behaviour research specialties, and study authors were consulted regarding ongoing and unpublished work.

Trials using physical activity or healthy diet promotion for at risk and diagnosed type 2 diabetes patients (adult only) were considered. Studies that included interventions lasting more than 3 months and reported outcomes after more than 1 year were sought, because of the progressive nature of type 2 diabetes and historical evidence that many lifestyle programs and strategies studied to date suffered from high attrition rates at follow up.^{6,17}

More than 200 appropriate papers specifically on prevention and management of type 2 diabetes, and a program of lifestyle modification using physical activity and diet, were obtained and critically appraised. Direct (level 1)¹⁸⁻²⁰ evidence for primary prevention of type 2 diabetes came predominantly from efficacy research. Evidence was for both physical activity and diet modification to delay onset of type 2 diabetes for at-risk patients, specifically patients with prediabetes.²¹ Studies support physical activity and diet (level I evidence)^{22,23} as interventions to improve and maintain glycemic control for people with diagnosed type 2 diabetes.

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Definitions

Prediabetes has two subtypes: impaired glucose tolerance and impaired fasting glucose.

Impaired glucose tolerance means that, after a 75-g oral glucose tolerance test, results of a 2-hour post-prandial glucose test range between 7.8 and 11.0 mmol/L.

Impaired fasting glucose means that fasting plasma glucose levels range from 6.1 to 7.0 mmol/L.

Data from the Canadian Diabetes Association Clinical Practice Guidelines Expert Committee.²¹

There was strikingly little and poor quality diabetes-specific evidence evaluating lifestyle-modification initiatives based in primary health care. Most studies had relatively small numbers of participants (both patients and physicians), demonstrated modest or no change in behaviour, had limited effect on key laboratory parameters (eg, glycosylated hemoglobin [HbA_{1c}]), and had minimal follow-up time (≤ 1 year). The following overview of large-scale studies investigating a program of lifestyle modification for both prevention and management of type 2 diabetes summarizes findings in primary care.

Prevention and lifestyle modification

Prospective cohort studies show that “low-risk lifestyle behaviour” can slow onset of type 2 diabetes in both adult men and women (level II evidence).^{24,25} Results from several large, long-term randomized controlled trials provide convincing evidence that changes made in physical activity levels and dietary habits are effective in delaying, and possibly preventing, progression from impaired glucose tolerance (IGT) to type 2 diabetes. **Table 1** summarizes outcomes for three key studies.^{18-20,26-28}

The Chinese Da Qing Study (level I evidence)²⁰ reported a 42% reduction in progression of IGT to diabetes over 6 years, based on an intensive regimen of exercise and diet therapy. The Finnish Diabetes Prevention Study (level I evidence)¹⁹ further substantiated that lifestyle change (for both men and women, using a rigorous program of diet and exercise therapy) reduced overall incidence of type 2 diabetes by 58% during the 3 years of follow up in this study.

More recently, the Diabetes Prevention Program (DPP) (level I evidence)¹⁸ in the United States examined strategies to evaluate the safety and efficacy of lifestyle and pharmacologic interventions to delay or

prevent development of type 2 diabetes in a diverse, high-risk population (with IGT). The DPP study reports that participants can reduce their chance of developing the disease by 58% through physical activity and diet, at 3-year follow up. The DPP’s two major goals were to achieve a minimum of 150 minutes of physical activity, similar in intensity to brisk walking, and a minimum of 7% weight loss and maintenance. The DPP program was coordinated and delivered by case managers or “lifestyle coaches,” had frequent (no less than monthly) follow up, and combined tailored individual and group support to enhance behaviour change using a 16-session core curriculum and “toolbox” of adherence strategies. Consideration was given to interventions deemed flexible and sensitive to cultural differences, as well as acceptable to the communities in which they were implemented. There was also an emphasis on self-esteem, empowerment, and social support to help participants achieve and maintain the study goals.^{26,27}

Costs associated with the DPP have recently been published estimating price per participant during the 3-year study.²⁸ The cost, from the perspective of the health care system (relative to the placebo group), of the lifestyle and metformin interventions was comparable (\$2269 versus \$2191, respectively, in US dollars). Future evaluation of costs relative to health benefit will determine the value of these interventions to health systems and society.²⁸

Diagnosis and lifestyle modification

Many trials have investigated lifestyle modification for diagnosed type 2 patients. This article provides an overview of best evidence: an expert review of weight loss²³ and a meta-analysis quantifying the effects of exercise²² in management of type 2 diabetes.

Weight loss and caloric restriction initially improve glycemic control; the amount of improvement is related to the magnitude of weight loss and duration of improvement.²³ Many different lifestyle programs involving diet, exercise, and behavioural approaches have been reported in studies of weight loss among diabetes patients. Programs that achieved close to a 7% decrease in body weight produced substantial changes in fasting blood sugar, approximately 11 mmol/L at baseline to 8.3 mmol/L after 3 to 6 months of weight loss (level I evidence).^{23,29}

A meta-analysis (level I evidence) aiming to determine which lifestyle interventions in type 2 diabetes promote improvement³⁰ showed diet reduced HbA_{1c} levels primarily in studies using very low caloric diets (VLCDs). The degree of caloric restriction involved in VLCDs appears to improve initial weight loss and

Table 1. Key lifestyle intervention studies for prevention of type 2 diabetes

STUDY: LEVEL OF EVIDENCE, TYPE OF TRIAL, COUNTRY	PARTICIPANTS N (AGE IN YEARS)	INTERVENTIONIST	INTERVENTION GOALS	INTERVENTION VS CONTROL GROUP (FOLLOW UP, OUTCOMES, EFFECTS)
Diabetes Prevention Program Research Group, 2002 ^{18,26-28} . • Level I • RCT • 27 centres in United States	3234 (25-85) IGT 45% members of minority groups 68% women	Case managers, study physicians, nurses, dietitians, exercise specialists	16-session curriculum in 24 weeks Physical activity 30 min/d, every day, walking or other moderate-intensity exercise, expend \geq 700 kcal/wk + Diet Low-fat diet to achieve loss of \geq 5%-7% of body weight Other Metformin+ standard lifestyle recommendations	At 3 years: Incidence T2D = 4.8, 7.8, and 11.0 patients per 100 person-years for lifestyle, metformin, and placebo groups, respectively Overall reduced risk of T2D: 58% lifestyle (95% CI, 48%-66%) 31% metformin (95% CI, 17%-43%) Weight loss: average was 0.1, 2.1, and 5.6 kg in placebo, metformin, and lifestyle intervention groups, respectively ($P < .001$) NNT = 7 people in lifestyle program, 13.9 in metformin group during 3 years to prevent 1 case of T2D DOR = 8% Cost: (over 3 years, relative to placebo)* Lifestyle = \$2269 per participant Metformin = \$2191 per participant
Tuomilehto et al, 2001 (Diabetes Prevention Study) ¹⁹ • Level I • RCT (by centre) • Finland	522 (mean 55) IGT 172 men 350 women	Study physicians, nurses, nutritionists, individual guidance to increase physical activity	7 sessions with dietitian in year 1, then 1 session every 3 mo thereafter Physical activity Supervised circuit-training program (aerobic and resistance), at least 30 min/d Diet Weight loss of 5% or more, reduce total fat intake (<30% of energy intake), limit saturated fat (<10% of energy intake), and increase dietary fibre (at least 15 g/1000 kcal), complete 3-day food record four times a year, receive individual feedback	At 4 years: Incidence T2D = 11% for lifestyle (95% CI, 6%-15%) vs 23% (95% CI, 17%-29%) ARR = 12% Overall reduced risk of T2D: 58% ($P < .001$) lifestyle group Overall reduced risk of T2D following proportional hazards analysis: Exercise only = 47% ($P < .001$) Diet only = 33% ($P < .03$) Diet + exercise = 38% ($P = .005$) Weight loss: mean 3.5 \pm 5.5 kg and 0.8 \pm 4.4 kg ($P < .001$) over 2 years NNT = 22 people for 1 year or 5 people for 5 years to prevent 1 case of T2D DOR \leq 9% lifestyle, <7% control Cost: not identified
Pan et al, 1997 (Da Qing Study) ²⁰ • Level I • RCT (by 33 health clinics) • China	577 (mean 45) 53% men with IGT	Clinic study physicians, nurses, technicians	Exercise Increase leisure physical exercise by more than 30 min of slow walking plus other specific descriptors Diet Frequent small group counseling stratified for BMI as to further intervention, BMI < 25 and BMI \geq 25 who were individually counseled	At 6 years: Incidence of T2D/100 person-years ($P < .05$): Exercise only = 8.3 (41.1%, 95% CI=33.4-49.4) Diet only = 10 (43%, 95% CI=35.5-52.3) Diet + exercise = 9.6 (46%, 95% CI=37.3-54.7) Control = 15.7 (67.6%, 95% CI=59.8-75.2) Overall reduced risk of T2D following proportional hazards analysis: 46% ($P < .0005$) exercise only 31% ($P < .03$) diet only 42% ($P < .005$) diet + exercise DOR = 8%, 47 did not complete study Cost: not identified

ARR—absolute risk reduction, BMI—body mass index, CI—confidence interval, DOR—drop-out rate of participants in study, IGT—impaired glucose tolerance, NNT—number needed to treat, RCT—randomized controlled trial, T2D—type 2 diabetes.

*Cost was reported in US dollars from the perspective of a health care system

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glycemic control, although when VLCDs are used in combination with behavioural intervention, this outcome has not been maintained in the long term (level I evidence).²³ Whether people with type 2 diabetes have more difficulty losing weight than people without diabetes, and the mechanisms accounting for this, require further study.^{23,31}

A meta-analysis by Boulé et al (level I evidence)²² reviewed and quantified the effects of aerobic exercise on HbA_{1c} levels and body mass among patients with type 2 diabetes. The investigators reported that the weighted mean difference in postintervention HbA_{1c} was clinically relevant (it decreased the risk of diabetic complications)³² and supported moderate exercise interventions on their own for diagnosed type 2 diabetes. A typical program prescribed three workouts per week, a mean of 53 (SD 17) minutes in duration, for 18 (SD 15) weeks, with moderate aerobic intensity usually consisting of walking or cycling. Investigators emphasized that exercise is “effective on its own, not solely as an avenue for weight loss” in management of type 2 diabetes.²² Potential harm from physical activity and dietary counseling for diagnosed type 2 patients was not found in studies in any of these reviews.

Lifestyle modification and primary health care

Although a strong body of evidence emphasizes the health benefits of lifestyle modification for people with type 2 diabetes, far less is known about the effectiveness of primary care-based strategies for achieving the physical activity and dietary changes necessary to acquire these benefits.³³ This “bottom line” has been validated by recent systematic reviews addressing behavioural counseling (routine counseling with follow up) by primary health care providers to promote physical activity (level I evidence)^{34,35} and healthy eating (level I evidence)³⁶ to the general adult population. These reviews acknowledge the difficulty of drawing conclusions from primary care-based studies completed to date, because they lack rigour and vary in population and study design.

There are few trials investigating lifestyle modification for type 2 diabetes in primary care. Of the few physician-based type 2 diabetes lifestyle intervention studies reviewed, one³⁷ focused on delivery of a brief, low-intensity intervention. Training focused on teaching physicians to be “catalysts for change”³⁸ using patient-centred advice or counseling in the context of routine 5- to 10-minute clinical visits, along with a variety of office supports. The intervention had an initial effect on behaviour but

made no significant difference in HbA_{1c} at 1-year follow up (level I evidence).³⁷

Multi-component interventions, including provider advice, supported with behavioural interventions (linked to the community) to facilitate and reinforce healthy levels of physical activity and dietary habits appear to be “most promising” for diagnosed type 2 diabetes (level III evidence).^{23,39} Some approaches actively being researched include office supports for physicians, such as reminder systems and trained office staff, access to other nonphysician health care professionals for referral, individualized and computerized patient materials, and links to community resources (Table 2^{6,15,16,33,37,40-46}).

Evidence applicable to primary health care providers

Table 2. Lifestyle modification for patients with type 2 diabetes: Several strategies should be incorporated in primary care evaluation studies

Family physicians can have an effective role in diabetes management through training and validated office-based tools for physicians, using a variety of assessing, advising, goal setting, and counseling techniques to promote lifestyle behaviour modification^{15,16,38,40}

Individualized planning and communication between provider and patient involves tailored, written materials for patients (computer- and Internet-assisted), follow-up maintenance programs, office system supports for maintenance (eg, reminder or prompt systems, central registries, office staff training for follow up)^{15,16,44,45}

An array of behavioural change supports should be put in place¹⁵

- Multi-component interventions and collaborative programs (individual and group) can promote patient self-management in chronic disease⁶
 - Interdisciplinary focus includes referral to nonphysician health care providers for ongoing patient support and maintenance (eg, dietitians, nurses, diabetes educators, behaviour consultants, and experts from physical activity and weight loss programs)^{41-43,46}
 - Links to community resources and programs enhance practice-based interventions and delivery from both patients' and broader environmental perspectives^{16,33}
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screening those at risk of developing type 2 diabetes and providing lifestyle counseling was not found, although one study that used trained primary care physicians to deliver nutritional counseling (along with office support) improved outcomes among adults at increased risk of diet-related chronic diseases (level I evidence).⁴⁰

There is good evidence that nurses and dietitians have a role in counseling and managing patients diagnosed with type 2 diabetes (level I evidence),^{41-43,47} although their role in promoting healthy lifestyle

choices for people with prediabetes is less evident. Referral to specialized diabetic centres (eg, Diabetes Education Centres or specialized regional programs) can provide patients with important information regarding outcomes, but evaluation data for such programs are limited and were not included in this review. The effect and possible harm from physical activity and dietary counseling for diabetes patients have not been well defined or measured.

Relevance for family physicians?

Larme and Pugh¹² reported that, while many physicians believe lifestyle intervention efforts are important in prevention and management of type 2

diabetes, they perceive such efforts as being ineffective. They echo similar practice challenges and social and environmental barriers experienced with patients facing other chronic diseases.⁴⁸

Family physicians can heighten awareness of healthy lifestyle choices by assessing, advising, and teaching patients, by encouraging patients to achieve goals supported by type 2 diabetes studies, and by reviewing resources available for patients within their communities.^{49,50} Whether action is taken depends on individual patients, their families, and support networks^{39,51} (Table 3^{21,52-57}).

Table 3. Lifestyle goals for type 2 diabetes patients

PATIENTS AT RISK (WITH IGT) OF DEVELOPING TYPE 2 DIABETES²¹

A program of lifestyle modification is most effective. To reduce risk of progressing to type 2 diabetes, patients with IGT should aim to accumulate 150 minutes weekly of moderate-intensity exercise (such as brisk walking). If they are overweight, they should undertake a hypocaloric diet aimed at losing 7% or more of initial body weight, ideally with a dietitian's guidance.

PATIENTS DIAGNOSED WITH TYPE 2 DIABETES^{21,52,53}

Patients should aim to accumulate at least 150 minutes of moderate-intensity aerobic exercise each week, spread out over at least 3 nonconsecutive days. If patients are willing, they should be encouraged to accumulate 4 hours or more of exercise weekly. All patients diagnosed with type 2 diabetes should receive *individual* advice on nutrition* from a dietitian.

PHYSICAL ACTIVITY RESOURCE

Health Canada. *Handbook for Canada's physical activity guide to healthy active living*.⁵⁵ FREE. Available through Health Canada in both English and French at: 1-888-334-9769 and <http://www.hc-sc.gc.ca/hppb/paguide>

HEALTHY EATING RESOURCES

Canadian Diabetes Association. *Just the Basics*[®] tips for healthy eating, diabetes management and prevention.⁵⁶ FREE. Available through the Canadian Diabetes Association in both English and French at: 1-800-226-8464 and http://www.diabetes.ca/Section_professionals/prof_tools.asp

Peterson WJ, Ludwig S. What to do until the dietitian comes! A resource guide for family physicians. *Can Diabetes*.⁵⁷ Available through the Canadian Diabetes Association at: http://www.diabetes.ca/Section_Professionals/pub_cd.asp

IGT—impaired glucose tolerance.

*Nutritional recommendations are the same as those of Canada's Food Guide to Healthy Eating.⁵⁴ Patients considering a change to their level of physical activity and those with serious peripheral neuropathy, who are treated with insulin, and with comorbid disease follow additional recommendations and need to consult with their physicians and diabetes health care team.

Conclusion

The literature has clearly identified the efficacy and relevance of lifestyle intervention in prevention and management of type 2 diabetes. As this chronic condition is principally identified and managed by family physicians, these findings apply directly to primary health care. This review identified a serious gap in the literature with respect to evaluation of the effectiveness of lifestyle intervention in primary health care for type 2 diabetes patients. If family physicians are to manage type 2 diabetes more effectively by "pairing aggressive clinical interventions with equally aggressive community action fundamental to broad lifestyle change,"⁵⁸ a valuable question still must be addressed: Can primary health care foster sustained lifestyle behaviour change? ❁

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Competing interests

None declared

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Editor's key points

- Level 1 evidence supports primary prevention of type 2 diabetes (T2D) through physical activity and diet modification.
- For patients with T2D, achieving a 7% reduction in weight improves blood sugar markers, although diabetic patients appear to have more difficulty losing weight than other patients.
- Moderate exercise (eg, 150 minutes weekly) improves blood sugar levels and has benefits beyond weight reduction.
- There is little good evidence for the effectiveness of primary care interventions in changing lifestyles or modifying key laboratory indicators, such as glycosylated hemoglobin (HbA_{1c}).
- Most promising are multi-component strategies that combine brief advice from physicians with links to community resources including dietitians, nurses, exercise programs, and specialized diabetes education centres.

Points de repère du rédacteur

- Il existe des preuves de niveau I démontrant l'efficacité de l'exercice et des changements dans les habitudes alimentaires pour la prévention primaire du diabète de type 2.
- Chez les diabétiques de type 2, une perte de poids de 7% améliore les marqueurs de la glycémie; ces patients semblent toutefois avoir plus de difficulté que les autres à perdre du poids.
- Un exercice d'intensité modéré (par ex. 150 minutes par semaine) améliore les niveaux de glycémie et procure des avantages au-delà de la perte de poids.
- L'efficacité des intervenants de première ligne pour susciter des changements du mode de vie ou modifier des indicateurs clés comme l'hémoglobine glycosylée (HbA_{1c}) n'a pas été évaluée de façon convaincante.
- Une approche multidisciplinaire associant de brèves recommandations du médecin à des ressources communautaires (par ex. diététistes, infirmières, programmes d'exercice et centres spécialisés d'éducation sur le diabète) semblerait plus prometteuse.

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