

Primary Prevention of Type 2 Diabetes

**A Critical Appraisal of Community Based Primary Prevention
Programmes**

Dr AP Lindsay
Public Health Medicine Registrar
Auckland Healthcare, Public Health Protection

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The question may not be can we afford to invest in a primary prevention programme but rather can we afford not to?

Executive summary

The aim of this report is to appraise the evidence supporting primary prevention programmes for type 2 diabetes by examining the experiences from overseas and in New Zealand and to describe the evaluation methodologies used in these interventions. This evidence will form the basis of recommendations for the primary prevention of type 2 diabetes.

In New Zealand a 30% increase in the prevalence of type 2 diabetes on 1998 levels is expected by the year 2006 assuming no increase in incidence rates. Maori and Pacific people have much higher rates of diabetes than the European population. It is unlikely that secondary and tertiary care services will be able to cope with the increasing number of people with diabetes predicted in the absence of programmes aimed at preventing type 2 diabetes.

A number of modifiable risk factors have been recognised and epidemiological studies have consistently shown a reduction in the incidence of diabetes by reducing obesity, increasing physical activity and to a lesser extent modifying diet.

Several major community based primary prevention programmes are currently underway overseas. Until these programmes have been evaluated there will be a lack of evidence on the effectiveness of such programmes in reducing the prevalence of type 2 diabetes in the population. There is, however, sufficient evidence from numerous epidemiological studies to justify the development and implementation of a community based primary prevention programme in Auckland.

The combination of high-risk and population based strategies would seem to be the most applicable approaches to any prevention programme in Auckland given the easily identifiable "at risk" populations. A number of studies have already been conducted in these populations and provide evidence for the effectiveness of the various interventions employed. The involvement of community groups and those working within the field of diabetes is vital for the success of any programme.

It is recommended on the strength of the evidence that a diabetes primary prevention programme be set up in Auckland. Further it is recommended that the programme:

- be community based, incorporating multiple interventions, and targeting a high risk population,
- targets the entire population including those currently at low risk such as pre-school and school students,
- should consist of three arms
 - Health promotion – through environmental and lifestyle changes, encouraging people to increase physical activity and eat a less energy dense diet,
 - Outreach – raising awareness about diabetes risk factors, signs and symptoms and complications among high risk communities, promoting screening of all antenatal women and opportunistic screening to identify previously undiagnosed diabetics,
 - Care - encouraging better self-care and better health professional care of diabetes, (through greater integration of care at the primary/secondary care interface, enhanced surveillance of health indicators and outcome measures, and purchasing strategies that reward best practice.)
- be evaluated. It will be necessary to determine evaluation processes, goals, methodologies, and the timing of reporting. A control community for comparative evaluation purposes should also be included,
- develop strong connections with communities and those working within these communities, so as to stimulate sustained change in individual behaviour patterns at a community level. This will require an understanding of the cultural and social environment of each community and the application of a community development model,
- continue to build on the existing relationships between New Zealand and other groups working on primary prevention of type 2 diabetes programmes, for example Auckland Healthcare Services and the USCDC-sponsored programme Project DIRECT in North Carolina,
- utilise existing health promotional skills, networks and expertise developed by other community projects,

- identify and include at all stages of development those groups involved in existing diabetes services and key community leaders in the intervention area. Also included should be local general practitioners and other health providers, dietary services, and organisations with an interest in the control of body weight and physical activity,
- be part of existing diabetes integration programmes or integrate with existing primary, secondary and tertiary diabetes care services, so as to build on the existing diabetes care infrastructure, and
- involve representatives from the transport and food industries, education sector and local government, as part of an inter-sectoral collaborative group to facilitate environmental change.

Key points

- **New Zealand is facing a rapidly growing epidemic of type 2 diabetes leading to a substantial burden of disease and huge impacts on resources.**
- **The control of obesity and promotion of increased physical activity through whole population approaches is the strategy most likely to prevent or reduce increases in the numbers of cases.**
- **This should be combined with high-risk group community development approaches and undertaken in close collaboration with other sectors supporting increased physical activity, and lower dietary fat and energy.**
- **These preventive strategies should be an integral part of a co-ordinated, comprehensive approach to diabetes control which includes enhanced, integrated clinical management closely linked with diagnosis and health outcome surveillance.**
- **The evidence supporting the primary prevention of type 2 diabetes comes from a wide range of epidemiological studies.**
- **Very few primary prevention programs have been conducted in and by the community. A small number of well designed studies are currently underway and provide some useful insights into their development, methodologies, and program evaluation.**
- **The evidence appears to be strongest for interventions aimed at reducing obesity and increasing physical fitness.**
- **Local studies provide evidence that diabetes education, dietary modification and increasing physical exercise can be achieved in the community.**
- **Enough evidence exists to commit to a community based multi-intervention type 2 diabetes prevention programme here in New Zealand.**

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Glossary and abbreviations

BMI	body mass index, $\text{wt}(\text{kg})/\text{ht}(\text{m}^2)$. Classification of obesity in Europeans BMI ≥ 30 .
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
NDDIM	Non-insulin-dependent diabetes mellitus. Also referred to as adult onset diabetes. These terms have been superseded by the term type 2 diabetes.
NGT	Normal glucose tolerance, non-diabetic
OGTT	Oral glucose tolerance test
Screening	In primary prevention this generally refers to screening of risk factors and individuals with IGT. To describe the prevalence of IGT in high prevalence populations or selective screening of high-risk individuals the 2h post glucose load is sufficient for epidemiological purposes. This differs from the diagnostic criteria in the clinical setting. ¹

1 Introduction

1.1 Aims

The aim of this report is to evaluate the evidence supporting community based primary prevention programmes for type 2 diabetes by examining the experiences from overseas and in New Zealand. A secondary aim is to describe the evaluation methodologies used in these interventions.

1.2 Scope

This report focuses on interventions which seek to prevent the development of type 2 diabetes. This approach is referred to as primary prevention. This is in contrast to secondary and tertiary prevention interventions which are aimed at individuals after they have developed diabetes. Thus the treatment of diabetes is not discussed in this report.

The report provides an overview of diabetes from an international as well as a New Zealand perspective. It reviews the evidence supporting interventions aimed at influencing the modifiable risk factors for type 2 diabetes. This evidence will form the basis of recommendations for the primary prevention of type 2 diabetes.

1.3 Background

Type 2 diabetes comprises about 85 – 90 % of all diabetes in developed countries including New Zealand.² The major risk factors for diabetes are obesity, age, physical inactivity, impaired glucose tolerance (IGT), and nutritional factors such as dietary fat and energy excess and low fibre intake. The 1996/97 Health Survey estimated that 3.7% of New Zealanders have diagnosed diabetes with Maori and Pacific Island people twice as likely than Europeans to have the disease.²

Rates of type 2 diabetes are increasing world-wide. It is estimated that by 2010 the world's diabetic population will have doubled from an estimated 110 million in 1994 to 221 million. The experience with type 2 diabetes in New Zealand mirrors what is happening

internationally. Some of this is due to population ageing – for example, in New Zealand a 30% increase in prevalence on 1998 levels is expected by the year 2006 due to ageing alone, assuming no increase in incidence rates. ³

An added burden to any increase in the prevalence of type 2 diabetes, apart from the human suffering, will be the financial cost of health care, which in New Zealand has been estimated at around \$250-600 million annually. ² It is not, however, inevitable that the predicted increase in the prevalence of type 2 diabetes will occur. The disease is preventable. Significant reductions in the risk of type 2 diabetes have been estimated by altering the modifiable risk factors. ⁴

2 Type 2 diabetes

This section describes the pathogenesis and natural history of type 2 diabetes disease. It will also cover the three risk factors for diabetes and the rationale for interventions aimed at modifying them.

2.1 The pathogenesis of type 2 diabetes

Type 2 diabetes covers a spectrum of degrees of glucose intolerance, ranging from people with no symptoms to those with severe symptoms. Impaired fasting glucose and impaired glucose tolerance are considered stages in the natural history of disordered carbohydrate metabolism. ¹ Progression through each stage is not inevitable (Figure 1). ⁵

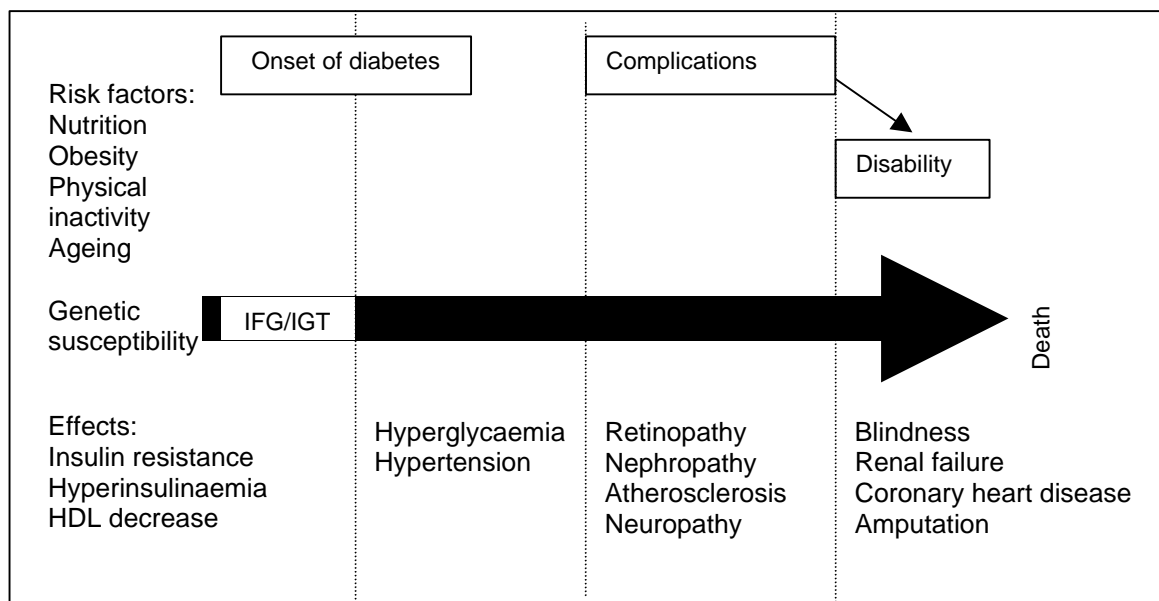


Figure 1. The natural history of type 2 diabetes. IFG = impaired fasting glucose, IGT = impaired glucose tolerance *Source: WHO 1994* ⁶

Three factors that are considered of importance regarding the pathogenesis of type 2 diabetes: ⁵

- individual or ethnic genetic susceptibility,
- pancreatic β -cell dysfunction, and
- decreased insulin action at target organs (insulin resistance).

Genetic susceptibility is not readily amenable to preventive interventions. In contrast, insulin resistance which is increased in people who are obese, physically inactive, and in those with IGT and type 2 diabetes, is potentially modifiable. It is thought that pancreatic β -cells eventually fail to secrete sufficient insulin to compensate for the increase in insulin resistance.

⁷ The progression of IGT to type 2 diabetes is reduced by interventions, such as regular physical activity, which decrease insulin resistance. ⁷ ⁶ Furthermore insulin resistance is also associated with a number of cardiovascular risk factors including hypertension, dyslipidaemia, generalised and central obesity, physical inactivity, hyperuricaemia, and microalbuminuria. ⁶

2.2 Modifiable risk factors for type 2 diabetes

Body weight and fat distribution

Populations with a high prevalence of obesity have been found to have higher rates of diabetes than those where obesity is less common. Obesity is believed to be associated with insulin resistance which is reversible with weight loss. ⁴ The risk of type 2 diabetes increases with increasing body mass index (BMI) in both sexes. A similar association exists between obesity and IGT, itself a risk factor for type 2 diabetes. Abdominal obesity has been implicated as a risk factor for type 2 diabetes in a number of different ethnic groups. ⁶

Nutrition

Decreased insulin sensitivity and abnormal glucose tolerance is associated with diets characterised by high intake of saturated fat, excess energy and low fibre content. Glucose tolerance has improved in some populations, who have returned to their traditional diets. ⁶

Physical activity

It is believed that physical activity reduces the occurrence of type 2 diabetes by increasing insulin sensitivity and/or altering the distribution of fat by preventing obesity. The importance of exercise was recognised by studies of societies that had abandoned traditional lifestyles and migrant groups.^{8 9} Those populations in which lifestyle changes have led to sedentary living with reduced physical activity have experienced increases in the incidence of type 2 diabetes.^{10 11} For example, Japanese migrants to Hawaii have a prevalence of diabetes twice that of those living in Hiroshima. A study of female former college athletes found that the incidence of diabetes in this group was lower than in those who were not as physically active. Another observation of this study was that, at the time of the survey these women were more likely to still be physically active.¹⁰ While this makes it difficult to separate the effects of historical from current physical activity on the occurrence of diabetes in the future, it does suggest that those who develop exercise habits in earlier life are more likely to continue these activities in the future.

The role of physical inactivity as a risk factor for type 2 diabetes is likely to be underestimated by studies that have examined the association of obesity and type 2 diabetes without correcting for the physical activity in their analysis.¹² The protective effect of physical activity on the development of IGT and type 2 diabetes has been found to be independent of BMI, family history of diabetes, and sex.¹² This effect is accentuated by any associated weight loss.⁶

3 Type 2 diabetes in New Zealand

3.1 Epidemiology of diabetes in New Zealand

In the 1996/97 Health Survey the prevalence of diabetes in New Zealand was estimated at 3.7%. This compares with 2% from the 1992/93 Health Survey², suggesting a trend toward an increasing number of people developing diabetes. It is estimated that between 30 – 50% of all cases of diabetes are undiagnosed.³

Age and sex

The 1996/97 survey found that diabetes increases significantly with age. While more men (4.1%) than women (3.3%) reported having diabetes, this difference was not significant.

It has been estimated that by the 2006, there will be a 13 % increase in the overall population, leading to a 30% increase in people with diabetes due to population ageing.³

Ethnicity

After controlling for age and sex the prevalence of diabetes among all New Zealanders, Maori and Pacific people have been estimated to be between 2 – 5 %, 5 – 10% and 4 – 8 % respectively.³ Similar figures were found in a study (1992 – 95) of inner urban South Auckland residents where the prevalence of known diabetes was 1.9% in Europeans, 5.2% among Maori, 4% among Pacific people, and 4.3% among other ethnic groups.¹³

These rates are consistent with observations that type 2 diabetes is particularly prevalent among 'transplanted' populations and indigenous peoples exposed to western lifestyles.

Gestational diabetes mellitus (GDM)

There is evidence that women with a history of diabetes in pregnancy have an increased chance of having a child with diabetes. This is thought to be due to in-utero exposure to maternal hyperglycaemia.¹⁴ Maori and Pacific women are more likely to have a history of diabetes in pregnancy than European women.

3.2 Modifiable Risk factors

The three recognised modifiable risk factors for diabetes are obesity, diets high in saturated fats, sugars and low fibre, and physical inactivity.^{7 15} The prevalence of trends for these is briefly discussed from a New Zealand perspective.

Obesity and weight

Compared with the a similar survey conducted in 1989, mean body weight has increased from 71.3kg to 74.5kg and central obesity has also increased from 27.4% to 41.4% of the New Zealand population. The current survey found that 35% of the adult population were overweight while 17% of the population were considered obese based on body mass index (BMI) measurements. Maori and Pacific people were more likely to be overweight or obese than Europeans. Waist to hip (W/H) ratio also increased between 1989 and 1997. Pacific people had the highest prevalence of W/H excess compared with Maori and Europeans.¹⁶

Diet

The 1997 National Nutrition Survey reveals that the New Zealand population continues to have a comparatively high fat diet (providing 35% of dietary energy) although the intake has decreased since 1989 (37.5 % of energy) and is moving nearer to the Ministry of Health target of 30-33% of energy. It should however be noted that direct comparison of findings of these surveys is not strictly valid as they used different methodologies. Saturated fat intake continues to be the predominant type of fat consumed and contributes 15% of energy, this sets NZ among the highest in the world and has only decreased by 1% since 1989. Most men and women do not meet the recommended daily fibre intake of 25-30 g/day with median intakes of 23g and 18g/day respectively. Only 18% of the population reached the New Zealand Nutrition Taskforce guidelines for servings of bread and cereals, 46% met the goal for fruit intake and 67% met the goal for vegetables.¹⁶

Physical activity

The 1996/97 New Zealand Health Survey found that 61% of adults in New Zealand were physically active. Physical active people were defined as those taking part in 2.5 hours or

more of leisure-time physical activity in the week prior to the survey. About 42% of Maori and 50% of Pacific people were considered inactive. ²

4 Prevention of type 2 diabetes

4.1 Levels of intervention

Given that there are a number of modifiable risk factors for type 2 diabetes, it is theoretically possible to prevent the development of the disease. The various periods of opportunity for the prevention of diabetes and the consequences of diabetes are illustrated in Figure 2.

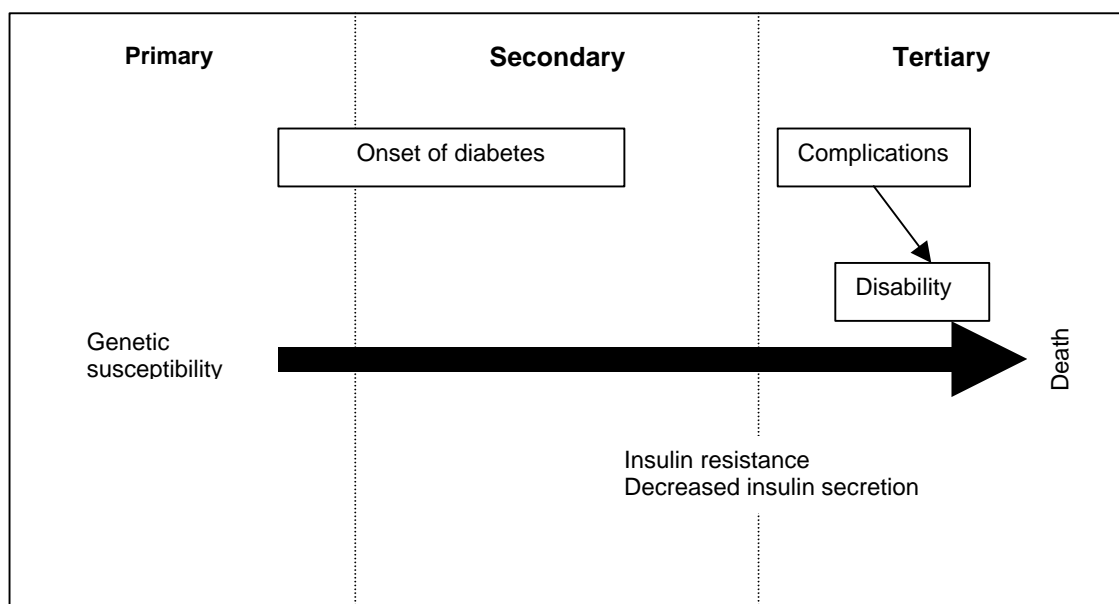


Figure 2. The natural history of diabetes and the three main levels of intervention for diabetes prevention. *Source: WHO 1994* ⁶

The levels of intervention are primary, secondary and tertiary and should not be confused with levels of care. For example primary prevention is not the same as primary care. While primary care may include elements of primary prevention, primary care often has more to do with the care of those with diabetes.

To make the distinction between the levels of prevention a short description of each follows.

Primary prevention

Primary prevention involves interventions which seek to prevent diabetes from occurring in susceptible individuals or populations.¹⁰ That is, prior to the development of clinically evident diabetes. This may be achieved by modifying environmental and behavioural risk factors.⁶ There are two main primary prevention strategies, high-risk and population approaches which are outlined below.

Secondary prevention

Secondary prevention refers to activities such as screening which aim to identify at an early stage individuals who already have IGT or diabetes. The purpose is to identify undiagnosed cases in time to offer early treatment which may reverse the disease or reduce its progression and the development of complications. Such activities are aimed at high-risk groups or at populations.⁶

Tertiary prevention

Tertiary prevention involves minimising the harmful effects or complications such as blindness, renal failure and amputation in individuals with diabetes.

4.2 Primary prevention strategies for type 2 diabetes

Two broad prevention strategies have been identified in relation to the prevention of non-communicable disease.¹⁷ The first aims to identify high-risk individuals in order to direct prevention activities at the level of the individual. The population strategy in contrast is aimed at controlling the determinants of a disease in the population as a whole.^{14 18 19}

High risk strategy

A high-risk strategy primarily relies on the identification of individuals at risk of diabetes and usually requires a screening tool to identify those at risk. Impaired glucose tolerance is considered an important risk factor for type 2 diabetes, and various tests are available for screening purposes. This approach has the advantage of directing appropriate interventions to the individual as well as providing potential motivation for individuals to make the necessary changes to reduce the impact of disease.

The high-risk approach may be assessed using controlled and in some circumstances randomised studies. A number of prospective studies have been conducted in subjects with impaired glucose tolerance, they have shown a reduced progression to type 2 diabetes by controlling weight, diet and increasing exercise. ²⁰

One disadvantage of the high-risk approach is the cost and difficulties surrounding screening*. Individual or group interventions are costly and need to be sustained for long periods. A further disadvantage of this approach is that it does not alter the underlying cause of the disease in the whole population as prevention and control measures are limited to those at risk. ¹⁸

Left unchanged, an unfavourable environment continues to promote an increase in the number of people with abnormal glucose tolerance by making behavioural changes difficult to achieve and sustain. ²⁰

Population strategy

The aim of the population approach to diabetes prevention *is to lower the mean level of risk for the entire population*. This not only increases the chance of preventing high risk individuals from developing type 2 diabetes, but also reduces the chance of individuals with low risk becoming high risk. ²⁰ Furthermore, strategies aimed at increasing physical activity, improving diet and reducing obesity are likely to have a positive effect on cardiovascular disease outcomes for people with established diabetes and cardiovascular disease.

* The use of the term screening is often confused, and when used in reference to primary prevention it should perhaps refer to the screening for risk factors for diabetes rather than the screening for previously undiagnosed diabetes.

However, a population strategy offers only a small benefit to each individual since most are not at risk anyway. It is therefore necessary to support initial education programmes with long-term strategies which causes change in the food supply. ¹⁸

Population strategies are harder to control and evaluate than intervention trials and it is seldom possible to conduct blinded randomised trials in these situations. This is because control groups or communities can be “contaminated” by interventions in the intervention group and they are also affected by prevailing secular trends. Having said that, control groups are required to assess the contribution of interventions to changes in outcomes.

Health promotion

Current strategies addressing diabetes have largely focussed on improving the management of established diabetes in order to mitigate complications (tertiary prevention). There is, however, evidence in support of comprehensive and co-ordinated epidemic control approaches that encompass primary, secondary, and tertiary prevention strategies. These seek to enhance linkages between the community, the health sector and community organisations along the lines of the Ottawa Charter so that

- the wider social, political and cultural environment is supportive of change in a health-promoting direction
- skills are developed by all involved
- community action is strengthened
- health services are re-oriented to give more attention to prevention and case detection, and to become more accessible, acceptable, effective, efficient and responsive.

5 Evidence for primary prevention of type 2 diabetes

5.1 Background

Epidemiological data supporting the roles of obesity, nutrition, and low physical activity as risk factors for diabetes have led to a wave of trials to prevent non-insulin-dependent diabetes through lifestyle interventions. The potential for benefit is suggested by epidemiological risk factor analyses indicating a reduction by 50-75% through control of obesity and 30-50% through increased physical activity.²⁰ The Ministry of Health supports in principle strategies aimed at modifying these risk factors.³

This section will briefly look at a previous review of the literature and describe the Australian strategy on obesity. This will be followed by a more detailed appraisal of the literature relating to the known modifiable risk factors.

Previous reviews of the evidence for primary prevention of type 2 diabetes

Manson et al (1994) reviewed a large number of published studies evaluating the evidence concerning the role of various risk factors in the development of type 2 diabetes.⁴ A meta-analysis of the studies was not possible due to their methodological diversity. The review was divided into five main areas:

- Prevalence of diabetes among migrant populations and native populations. Ecologic data from migrating populations support the impact of modern lifestyle factors on the risk of developing type 2 diabetes.
- Obesity. Ecological studies show a higher rate of type 2 diabetes among those who are categorised as obese compared to non-obese populations. Obese populations such as Pima Indians and Nauruans, both have high prevalence rates. Cohort studies have also shown a positive association between BMI and the risk of developing diabetes. The estimated reduction in risk by maintaining desirable body weight (BMI \leq 22.4 in women

and ≤ 22.7 in men), compared with being obese, that is over 20% above desirable weight (BMI ≥ 27.3 in women and ≥ 27.8 in men) is 50 – 70 %.

- Body fat distribution. Studies using a range of designs in a range of ethnic groups consistently found a positive association between central obesity and risk of type 2 diabetes, even after controlling for potential confounders such as overall obesity and physical activity.
- Dietary factors. Despite a range of study designs they could not demonstrate an association between consumption of fat, protein, or sugar and type 2 diabetes. None of the studies appeared to examine the role of dietary fibre. It was concluded that this was an area in need of further research.
- Physical activity. The evidence from cohort studies which controlled for BMI, age and some social factors such as socioeconomic status consistently showed a reduction in risk for type 2 diabetes in those who were physically active compared to sedentary individuals. However no overall conclusion could be drawn on the frequency, intensity or duration of exercise required to reduce this risk. Overall it was estimated that the reduction in the risk of diabetes associated with regular moderate or vigorous exercise compared to a sedentary lifestyle is between 30 – 50%.

Despite the absence of randomised trials demonstrating an association between changing weight, diet, physical activity or body fat distribution (around the time this review was published) one can conclude that the evidence from epidemiological studies was sufficient to suggest that the impact of modifying these risk factors on the risk of developing diabetes would be significant.

Australian strategic plan for the prevention of overweight and obesity

The National Health and Medical Research Council of Australia has developed a strategic plan for the prevention of overweight and obesity. The report comprehensively analysed the causes of obesity, prevalence in the Australian population, and the role of physical activity in weight reduction. It also demonstrated that apart from the health benefits associated with the prevention and treatment of obesity there were also significant economic gains to be made.²¹

The report also provides a framework for influencing physical activity in Australia. A number of important initiatives have included public health policy that contains elements of an environmental and social approach to the promotion of physical activity. The aim of community based programs is to address the problem of overweight and obesity in those that are not already exercising. It is believed that this approach will have the greatest impact on weight reduction.

The strategic plan was adopted from work done by Egger and Swinburn who developed an ecological paradigm for understanding obesity (Figure 3). The model was developed in recognition of the influences on health, which are outside the control of individuals. A number of examples are given where effective change in public health did not occur until the environment was modified, for example, road crashes and median barriers. Figure 3 represents the three main areas influencing the development of obesity, the host, the mediating factors or vehicle of fat/energy intake (food) and energy expenditure (physical activity), and the environment. The macro- and micro-environment can be broken down into physical and sociocultural components. The various interventions overlay the triad. Presently interventions aimed at environmental change are deficient.

The time frame for the implementation of the strategy is ten years with an evaluation after five years. It will involve the development, promotion and implementation of physical activity and dietary guidelines. It will also promote the importance of healthy weight control. The food

industry will be involved in labelling and increasing the proportion of foods on the market with low or reduced fat levels.

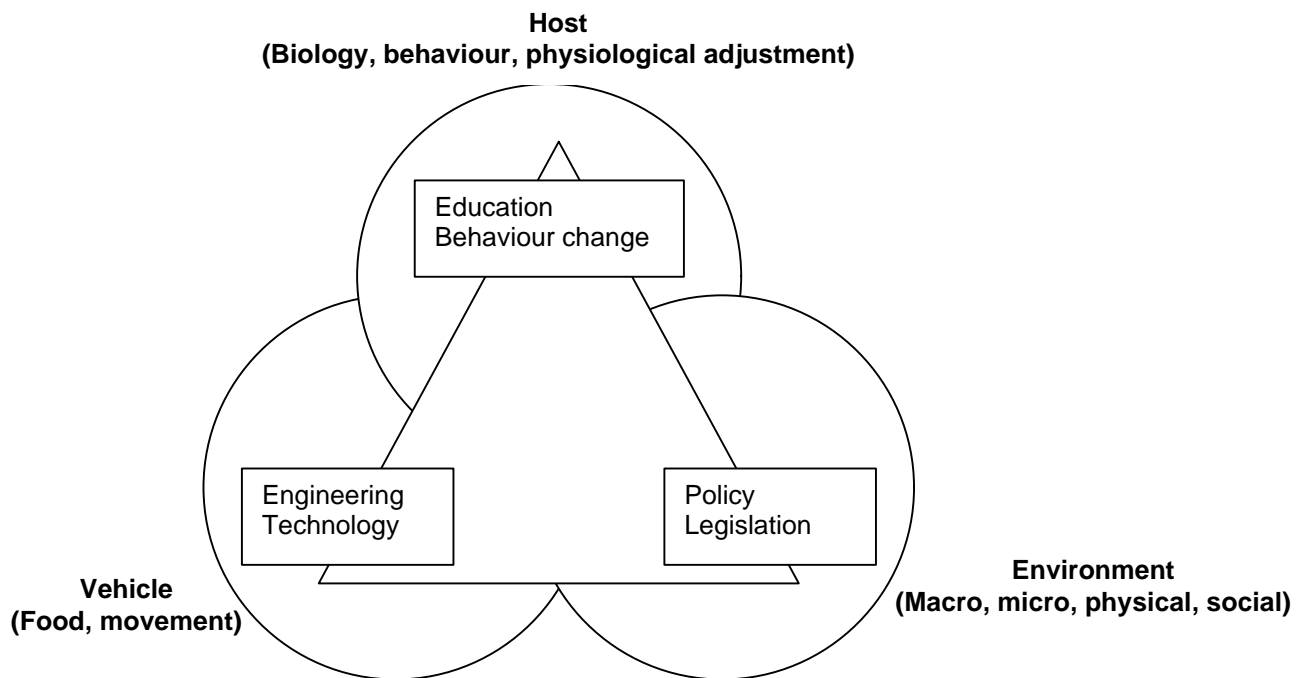


Figure 3. The epidemiological triad and potential intervention strategies. Source: NHMRC strategic plan 1997²¹

Various programs will be introduced in the workplace to encourage healthy food choices and to develop opportunities for physical activity within the work routine. Schools will also be encouraged to incorporate daily physical activities and healthy food guidelines in school canteens. At a community level various agencies will be involved in increasing the opportunity of planned as well as incidental physical activity through the planning of the physical environment to facilitate this. Public and private sector food services will be encouraged to offer health food choices consistent with dietary guidelines. Those involved in healthcare and research will play an important role in providing leadership in the prevention of overweight and obesity in their communities. The strategy will include a monitoring and evaluation program to monitor changes in weight and physical activity. Finally a strategic planning committee will be set up to co-ordinate the implementation of the plan.

The report identified physical activity as a key intervention to reducing overweight and obesity. However, it was emphasised that there was a need for multisectoral public health initiatives aimed at increasing the level of physical activity in the population.

The report also reviewed the performance of several community cardiovascular risk-factor intervention studies with respect to their effect on weight reduction. The following studies were included: The North Karelia Project, The Stanford Three Community Study, The Stanford Five City Project, and The Minnesota Heart Health Program. Although these interventions had little or no impact on weight, this was thought to be due to their lack of emphasis on environmental change.

In developed countries where energy dense foods are heavily promoted and a sedentary lifestyle more common, individual behaviour changes are likely to be less effective. ²¹ Broader social and environmental factors such as the food supply, town planning, and public transport need to be recognised and taken into account if primary prevention interventions are to be effective.

These views are shared by others who also recognise that a reduction in obesity is required before a reduction in type 2 diabetes is seen, and that this will only be achieved if there are changes in the environment. ²⁰ It is firmly believed that these changes must be directed at the level of the food supply in terms of government policy, manufacturing, and marketing of food. The overall aim being to reduce the total amount of fat in the food supply and providing healthy food choices using the Ottawa charter as a framework. ¹⁴

5.2 Critical appraisal of the evidence

Objectives of the literature review

The purpose of the literature review are two fold:

1. to appraise the existing evidence relating to the primary prevention strategies for type 2 diabetes, and
2. to determine the evaluation methodologies used in interventions aimed at the primary prevention of type 2 diabetes.

Methods

- Medline database and the Cochrane database were used to identify relevant literature. Publications were restricted to those in the English language between the years 1990 to 1999
- Selected journals with an emphasis on diabetes were searched manually for articles on diabetes and primary prevention
- Internet sites including those of the Ministry of Health, CDC Atlanta and World Health Organisation were examined
- Key words used in the search included, singularly or in combination: Diabetes, type 2 diabetes, NIDDM, prevention, primary, primary prevention, obesity, diet, nutrition, physical exercise, IGT, glucose intolerance and risk factors. From the bibliographies of those references found by the above search methods further articles were selected.
- Additional material was added through personal communication with experts in the area of diabetes, exercise and nutrition. For example, experts associated with the Green Prescriptions, Auckland Healthcare Public Health Nutrition, and New Zealand Heart Foundation were consulted.

The literature appraisal is divided into two sections. The first presents the findings from overseas research while the second section examines work conducted in New Zealand.

5.3 Overseas diabetes intervention trials

This section appraises the overseas literature under two headings:

1. epidemiological studies, and
2. community based intervention trials.

Epidemiological studies

Table 1 lists the overseas epidemiological studies appraised in this report. The studies consist of a range of epidemiological study designs, evaluation endpoints and outcomes, populations, and ethnicities. The studies examined the role and effect of interventions on the important risk factors for diabetes, namely obesity and fat distribution, diet, and physical inactivity.

Obesity and fat distribution

All the studies that examined weight consistently found the risk of diabetes increased with increasing body mass index (BMI).²² With respect to weight gain, the incidence of diabetes was positively associated with weight gain.²³ Similarly weight loss was associated with a reduced risk of type 2 diabetes. The greater the weight loss the greater the reduction in risk (for 5kg loss RR 0.54, for >20kg loss RR 0.13).²⁴

Diet

The amount of dietary fibre was found to be inversely proportional to the risk of developing type 2 diabetes (RR 0.72, 95% CI, 0.58 – 0.90), with an increased risk associated with diets consisting of a combination of high glycaemic load and low cereal fibre (RR 2.5, 95% CI, 1.14 – 5.51).²³

Inconsistent findings were reported with respect to dietary fat. One cohort study found that newly diagnosed diabetics had higher intakes of saturated, monounsaturated fat and cholesterol compared to non-diabetics,²⁵ while the Nurses study was unable to demonstrate a relationship between fat intake and the development of type 2 diabetes.²⁶

Physical activity

Studies that examined the role of physical activity in type 2 diabetes consistently found a positive association between inactivity and increased risk of diabetes. In both men and women the risk of type 2 diabetes decreased with moderate to vigorous physical activity independently of BMI. ^{11 22 27} Comparisons between studies were not possible as the definitions of physical activity levels were not the same.

Physical activity and diet

An intervention trial using a combination of dietary and physical interventions in men with IGT recorded a decrease in the conversion rate to diabetes. People with IGT who received dietary advice and increased their physical activity levels had similar mortality rates compared with those with normal glucose tolerance (NGT). The relative risk of developing diabetes in men with IGT compared with those with IGT not receiving these interventions was 0.5 (95% CI, 0.3 – 1.0) ^{28 29}

A large intervention trial (577 people with IGT) in Da Qing, China identified men and women with IGT and randomly assigned to one of four groups: controls and a combination of diet and/or exercise interventions. The study found a 25% - 50% lower incidence of diabetes in the intervention groups compared with the control group. ³⁰

Summary

The greatest scope for preventing the development of type 2 diabetes lies in interventions that increase physical activity and reduce weight. The evidence surrounding dietary interventions is less consistent and more research is required in this area to clarify the role of diet in preventing diabetes.

Table 1. Intervention trials: Diet and/or exercise

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Da Qing IGT and diabetes study. China 30	To determine whether diet and exercise interventions in those with IGT may delay the development of NIDDM	577 identified with IGT from 110,660 men and women following screening using WHO criteria. 47 lost to follow up. 4 groups – control, diet only, exercise only, or diet and exercise. Diet/exercise intervention groups given advice and set individual goals. Use of small groups and individual counselling on a regular basis. Control group received general information about diabetes and IGT but no individual or group sessions.	Randomised clinical trial. Individuals randomly assigned to one of 33 clinics. Each clinic offering one of the possible interventions	6 year follow up	Initial screen using plasma glucose 2 hours after a standard breakfast. If screen positive then OGTT performed and categorised by BMI. Baseline BP, height and weight, and lipids. Family and past history of diabetes noted. Food intake and exercise quantified, occupation also recorded. Repeated initial screening tests 3 times at 2 year intervals. 3 month follow up visits, OGTT repeated if indicated by plasma glucose or urinary glucose measures. Development of diabetes is an end point.	After 6 years the incidence of diabetes in the control group was 15.7/100 person years (95% CI, 12.7 – 18.7), diet 10/100 person years (95% CI, 7.5 – 12.5), exercise 8.3/100 person years (95% CI, 6.4 – 10.3), diet and exercise 9.6/100 person years (95% CI, 7.2 – 12.0), (p < 0.05 for all). No significant difference found among the 3 intervention groups. Study demonstrates a 25 – 50% lower incidence of diabetes in intervention groups than the control group.	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Malmö preventive trial. Sweden 28	To evaluate mortality rate of men with IGT who participated in a NIDDM primary prevention programme compared to IGT routine and men with normal glucose tolerance	6956 48 year old men from Malmö Sweden. 144 with diabetes (diabetes group) 423 with IGT, of whom 288 were assigned to the organised dietary therapy and exercise programme (IGT intervention group) and 135 received routine treatment (IGT routine treatment), and 6389 NGT men	Non-randomised intervention trial. Began 1975/79	12 year follow up	<p>Initial screening: height, weight, triceps skin fold, forced lung capacity, BP, resting heart rate, ECG, maximum oxygen uptake 2-h oral glucose tolerance test (GGT)(93%) or 90 min IVGGT (7%), capillary blood glucose, plasma insulin and blood lipids</p> <p>Annual checks for first 6 years, it is not clear if all initial screening measurements were repeated each year</p> <p>IGT group followed for a further 6 years</p> <p>Mortality using registry at Statistics Sweden</p>	<p>After first six years: the average annual conversion rates to diabetes were 0.3% (NGT), 1.7% (IGT intervention) and 4.6% (IGT routine treatment). Significance and confidence intervals not stated.</p> <p>Mortality was followed for 12 years (per 1000 person years at risk) for all causes: NGT 6.2, IGT (intervention) 6.5, IGT (routine) 14.0, and 22.6 (diabetics)</p> <p>Conclusion: Lifestyle changes, including dietary counselling and physical exercise reduces mortality in subjects with IGT who are at increased risk of developing NDDIM and premature death due to IHD</p>	IGT groups not randomised. Dietary and physical interventions not specified.

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
6 year Malmo feasibility study. Sweden 29	To test the feasibility of lifestyle of long term intervention with an emphasis on changes – diet and physical exercise	415 men (avg age 48 years): Intervention group 41 newly diagnosed diabetes (group 1) and 181 with IGT (group 2). Comparison groups 79 with IGT (group 3) and 114 with NGT (group 4). Intervention: dietary advice and physical activity with a choice of supervised or organised groups or individually.	Non-randomised intervention trial. 1974 - 1985	5 year follow up	Initial screening: oral glucose load, capillary blood glucose, plasma insulin, serum cholesterol and plasma triglycerides, BMI, triceps fold, BP and maximum oxygen uptake. Follow-up measurements after 5 years 30% drop out of comparison IGT group	Oxygen uptake improved in groups 1 and 2 by 14% ($p < 0.03$) and 8% ($p < 0.002$) respectively, and lower values in groups 3 and 4 by 2% (p ns) and 8% ($p < 0.001$) respectively. Weight reduction of between 2 – 3.3 kg in groups 1 and 2 in 82% ($p < 0.0001$) and 71% ($p < 0.0001$) of subjects respectively maintaining a weight reduction. Groups 3 and 4 gained between 0.2 - 2 kg. 2h glucose tolerance improved in groups 1 and 2 and maintained. Prevalence of type 2 diabetes and IGT at follow up: group 1 improved with 58% in remission, group 2 75.8% showed improvement, 10.6% developed diabetes, group 3 deteriorated in 67.1% and 21.4 developed diabetes. No cases of diabetes in group 4. RR (between groups 2 and 3) of developing diabetes 0.5 (95%, CI 0.3 – 1.0)	IGT groups not randomised.

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Nurses Health Study 1976 - 90 11	To examine the association of regular activity and the subsequent incidence of NIDDM	87,253 non-diabetic female registered nurses aged 34 – 59 years when enrolled in 1976 from a total cohort of 121,700. 98% of participants are white.	Cohort study	1976 – 1988. 8 year follow up from 1980. Follow up rate over 92%.	Questionnaires in 1976 asked about previous diabetes, age, height and weight. Every two years follow up questionnaires were sent until 1988 asking for an update of diabetes status and weight. In 1982 questions were asked about frequency and vigour of any physical activity. Those reporting diabetes prior to 1980 were excluded from the study. All cases of type 1 diabetes and gestational diabetes only were also excluded. Obesity was defined as a BMI ≥ 27 .	1303 cases of NIDDM were confirmed. Compared with sedentary women age adjusted RR of NIDDM among women exercising at least once/week was 0.67 (95% CI, 0.6 – 0.75, $p < 0.001$). After adjusting for age and BMI, the RR increased to 0.84 (95% CI, 0.75 – 0.95, $p < 0.005$). A reduction in risk occurred in women who exercised whether or not they were obese. All results remained statistically significant irrespective of family history of diabetes. No dose-response relationship was found between frequency of vigorous exercise and subsequent incidence of NIDDM.	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Nurses Health Study 1976 - 90 ²⁶	To examine prospectively the relationship between glycaemic diets, low fibre intake, and the risk of non-insulin-dependent diabetes mellitus	Of 75,543 women aged 40 – 65 years, 65173 were free from diagnosed cardiovascular disease, cancer and diabetes, met the predefined daily energy intake and completed the diet questionnaire adequately. Also excluded were women with type 1 diabetes or gestational diabetes only.	Cohort study	1986. 6 year follow up	1986 diet was assessed semi-quantitatively food frequency by validated questionnaire. Excluded from the study were those who did not have a dietary intake of between 2512 and 14654 kJ and those who left 10 or more blanks among the 134 total food items. From this information glycaemic index and load were derived. Other information collected included weight, smoking status, physical activity and family history of diabetes. Follow up was every 2 years asking about whether diabetes had been recently diagnosed.	915 cases of NIDDM were diagnosed in the 6 years of follow up. Total energy was weakly and positively related to risk of NIDDM after adjusting for age, obesity, alcohol consumption, smoking, physical activity and family history. Neither fat intake (animal or vegetable), mono or poly unsaturated fat, nor the ratio of polyunsaturated to saturated fat were statistically significant. A median intake of total dietary fibre of 24.1 g/d compared with 11.8 g/d was associated with a risk reduction for diabetes, RR 0.78 (95% CI, 0.62 – 0.98). Median cereal fibre intake of 7.5 g/d compared to 2 g/d resulted in a RR 0.72 (95% CI, 0.58 – 0.90). The RR for the combination of high glycaemic load and a low cereal fibre compared to a low glycaemic load and high cereal fibre was 2.5 (95% CI, 1.14 – 5.51). Conclusions: Regarding the combination of glycaemic load and fibre it is important to examine the quality and quantity of carbohydrates consumed when evaluating the risk of NIDDM. Grains (minimally refined) should be consumed to reduce the risk of NIDDM.	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Pima Indians USA 1995 23	To analyse the incidence of diabetes in relation to weight fluctuation and rate of weight gain	<p>Rate of weight gain analysis: 552 men and 906 women over 20 years at first examination. Weight fluctuation analysis: 383 men and 201 women. Correlation analysis. Population with a high prevalence of obesity and diabetes.</p> <p>Causes of weight change not recorded.</p>	Cohort study	Since 1965. 2 year follow up	<p>Height and weight (BMI), waist and hip circumference (from 1990), 75g OGTT (repeated at each examination), and fasting serum insulin concentrations (since 1987)</p> <p>2 year follow up (approx.)</p> <p>Development of diabetes is an end point.</p>	<p>Rate of weight gain. Rate of weight gain decreased with age in men and women. After about 7 years 34% of women and 28% of the men developed NIDDM. In men the incidence increased with greater rate of weight gain whether or not they were initially overweight. In both men and women the incidence of diabetes increased with incidence of obesity. These findings were significant, $p < 0.01$.</p> <p>Weight fluctuation. After about 6 years 28% of subjects developed diabetes. There was no association between weight fluctuation and diabetes incidence.</p> <p>Correlation analysis. Rate of weight gain was associated with 2-h plasma glucose level in both men and women.</p> <p>This study supports interventions that induce weight loss or slow the rate of weight gain. Weight loss is more beneficial to overweight men than women while prevention of obesity will benefit both sexes.</p>	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Nurses Health Study 1976 - 90 ²⁴	To examine the relation between adult weight change and the risk for clinical diabetes mellitus	114,824 non-diabetic female registered nurses aged 30 – 55 years when enrolled in 1976 from a total cohort of 121,700. 98% of participants are white. 89 subjects developing type 1 diabetes were excluded from the study. Also excluded were those who had gestational diabetes only.	Cohort study	Since 1976. 14 year follow up. Follow up rate over 90%.	By questionnaire: height and weight recorded at start of study. At the first follow up questionnaire each subject was ask to record their weight at age 18 and any family history of diabetes. Every two years weight recorded and whether diabetes mellitus had been diagnosed in the previous 2 years. Development of diabetes is an end point.	The risk of diabetes increased with BMI. RR ranged from 2.9 (CI 95% 2.0 – 4.1) for a BMI between 22.0 – 22.9 to 93.2 (CI 95% 81.4 – 106.6) for a BMI between 33.0 – 34.9. Those that lost more than 5 kg over the 14 years had a reduced risk of diabetes ranging from a RR of 0.54 to 0.13 for weight reductions of between 5kg and over 20kg.	
Perry 1995 ²²	To determine the risk factors for non-insulin dependent diabetes	7577 randomly selected men aged 40 – 59. Excluded were known (n = 14) or probable cases (n = 23) of diabetes at screening based on a non-fasting glucose \geq 11.1 mmol/l	Cohort study	12.8 years	Questionnaire on a range of personal behaviours including smoking, alcohol intake medical history and drug use. Physical activity was based on frequency and intensity of activities reported. BMI calculated, and non-fasting glucose were measured. Follow up included morbidity and mortality for a mean period of 12.8 years. Determination of confirmed diabetes was assessed at 5 years. Follow up occurred after 5 years (98% response) and at the end of the study (91%). Development of non-insulin dependent diabetes the outcome of interest.	194 new cases of non-insulin dependent diabetes were detected during the study (incidence = 2.15/1000 person years). Those who developed diabetes had a higher mean blood glucose at screening (6.2 v 5.4 mmol/l p < 0.0001), and a higher BMI (27.9 v 25.4 p < 0.0001) with increasing risk with increasing BMI. There was no difference in age between those remaining non-diabetic and those developing diabetes. The risk of diabetes decreased with increasing physical activity up to moderate levels of activity after which the risk increased. The RR (moderate v inactivity) was found to be 0.4 (95% CI 0.2 – 0.7).	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Seven Countries study 25	To investigate the role of diet as a predictor of glucose intolerance and non-insulin dependent diabetes mellitus	338 men were included from the Seven countries study initiated in 1958 Excluded were those with diabetes at the 30 year follow up.	Cohort study	1958/64 – 1989/90	Diet data at 10 and 30 year follow up and glucose tolerance at the 30 year follow up survey.	Men were between 70 and 89 years old at time of OGTT. Prevalence of newly diagnosed diabetes at 1989/90 was 8%, and 21% of the men had IGT. Compared with NGT men IGT men had a lower proportion of protein and a higher proportion of mono and disaccharides in their diet. NGT men had the lowest mean BMI. Newly diagnosed diabetics had the highest intake of saturated, monounsaturated fat and cholesterol compared to NGT men ($p < 0.05$) after controlling for age and BMI.	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
US male physicians. 27	To examine prospectively the association between regular exercise and the subsequent development of non-insulin-dependent diabetes mellitus (NDDIM)	21,271 US male physicians aged 40 – 84 years old. Excluded those with diagnosed diabetes, myocardial infarction, cerebrovascular disease, and cancer at baseline.	Cohort study	5 year follow up. 99.7% complete morbidity follow up	Baseline information obtained by questionnaire included frequency of vigorous exercise, height and weight. Follow up 6 monthly for the first year and annually thereafter using questionnaires asking about new medical diagnoses including diabetes. Participants were categorised by the frequency of weekly exercise. Outcome measure NIDDM	<p>285 cases of diabetes were diagnosed during the 5 years of follow up. The incidence of diabetes was inversely related to the frequency of vigorous exercise (p, trend, < 0.001). RR (men exercising vigorously at least once/per week vs sedentary men) = 0.71 (95% CI, 0.51 – 0.82, p = 0.0003) after adjustment for BMI and age.</p> <p>A dose relationship between increased exercise with a decreased risk of NIDDM. RR of NIDDM declined from 1.0 (referent category of exercise less than once/week) 0.77 for weekly, 0.62 for two to four times/week, 0.58 for five or more times/week (p, trend, < 0.0002), with adjustment for BMI the RRs were 1.0, 0.78, 0.68, and 0.71 respectively (p, trend, < 0.009).</p> <p>In obese men (BMI > 26.4) the RR (sedentary men v men exercising vigorously at least once/per week) = 0.61 (p = 0.005). Hypertension was also found to be associated with an increased risk of NIDDM (RR 2.03, 95% CI, 1.47 – 2.80).</p> <p>Conclusions: exercise reduces the development of NIDDM even after adjusting for BMI.</p>	

Table 1 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Wannamethee 31	To examine the relationship between weight change and duration of overweight and obesity and the incidence of type 2 diabetes in middle aged men	From 7100, 6916 men from one general practice in 24 British towns who did not have (confirmed) diabetes at the beginning of the study and took part in an initial screen 5 years earlier as part of a cardiovascular disease study. Those with non-fasting glucose $> = 11.1$ micro mol/l at that screen were also excluded.	Cohort study	11.8 years. 99% follow up	Initial screening (1978/80, 5 years prior to the start of the study) by research nurses collected information on physical activity and medical history. Non-fasting blood glucose and BMI calculated. At the start of the study a postal questionnaire was sent to the men asking about change in weight, smoking and drinking behaviour. This had a 98% response rate. (1983/85) Follow up also at 1992 (91% response rate) with a further questionnaire and review of primary care records. Weight change in the first five years was used to see if there was a relationship with the risk of diabetes in the subsequent 12 years of the study. Those who gained $> 4\%$ of their initial weight were considered to have gained weight. If $< 4\%$ gain or loss in weight was defined as stable. Weight loss was defined at a weight reduction of at least 4%. Weight definitions used were BMI $> = 25$ overweight, 28 – 30 borderline obese and $> = 30$ obese.	237 cases of diabetes were diagnosed during the 12 year follow up, giving a rate 3.2/1000 person years. 54% maintained a stable weight, 31% gained weight 13% lost weight in the initial 5 years. Risk of diabetes increased with weight change $> 10\%$, but this was not significant after adjusting for initial weight RR = 1.89 (95% CI, 1.19 – 3.01). The RR of diabetes increased with increasing BMI and duration of obesity ≥ 5 years. For cases with a BMI ≥ 30 for > 5 years the RR was 8.66 (95% CI, 5.06 – 12.74) compared to those men with BMI < 25 . Results were inconclusive, difficult to interpret and frequently changes were not significant.	Furthermore weight change was only recorded in the five years prior to the beginning of the study. Weight could have been measured during the study and at its completion for a better indication of weight change.

BMI body mass index $\text{wt}(\text{kg})/\text{ht}(\text{m}^2)$, BP blood pressure, IGT impaired glucose tolerance, NGT normal glucose tolerance, OGTT oral glucose tolerance test, IVGGT intravenous glucose tolerance test, IHD ischaemic heart disease

Community based intervention studies

A small number of trials were found which have been set up in the community, with community participation and involvement. Generally these studies run over several years employing a number of interventions and health promotion strategies. As these studies have only been recently implemented, published material is limited to those reporting early results of pilots used to establish baseline measures. No articles are therefore currently available which have evaluated or quantified the long-term effectiveness of the interventions they employed in terms of health outcomes. An overview of these studies follows as they give valuable insight into their design and methods of evaluation.

Project DIRECT (North Carolina, USA) 32

Project DIRECT is a multiyear study that was set up in 1990 in response to the increasing prevalence of diabetes in the USA, particularly among African Americans, with the support of the Centers of Disease Control and Prevention (CDC) in North Carolina. The project incorporates an integrated approach with interventions aimed at improving the health care among people known to have diabetes as well as preventing type 2 diabetes. The latter aim was included even though the researchers recognised that the evidence for dietary modification and an increase in physical activity in preventing diabetes is not rigorous.

A community strategy was considered appropriate as the risk factors among African Americans are both common and modifiable and the community environment was believed to be an important factor influencing these risks. The rationale behind this was based on the notion that a small reduction in high-risk behaviours across an entire community can have a large impact. This approach was also favoured as modification of these risk factors are likely to benefit both those at risk of diabetes as well as those with known diabetes.

The project gained support despite the unimpressive results of interventions to reduce cardiovascular disease risk factors. A number of key features of this project, in the opinion of the researchers, are thought to increase its chances of success. These include a community

orientated focus, the targeting of those at risk, and a commitment to gain an adequate understanding of the community structure and dynamics that influence change.

The study was conducted in a community chosen because of its ethnic background, its interest in the project, strong support from local health agencies, and the presence of a well developed network of local agencies with a good understanding of the community's structure.

A pilot study was conducted prior to the project's start-up to assess the expected community participation rate, acceptability of survey interviews and examinations ³³, prevalence of diagnosed and undiagnosed diabetes and its complications, and current preventive measures and health services. ³⁴

The project employed three main areas for intervention: health promotion, outreach and diabetes care.

- The broad aims of the health promotion interventions were to reduce the modifiable risk factors for diabetes in the general population by increasing participation in regular physical activity and decreasing fat intake.
- An outreach programme to increase the awareness of the risk factors for developing diabetes, increase screening for diabetes among those at risk, and to increase the uptake of health services for those with diagnosed diabetes. Again several modalities of interventions were used to achieve this, and
- To support primary care providers to improve the quality of diabetes care delivered to people known to have diabetes.

Evaluation is considered essential to determine the effectiveness of the interventions and their applicability to other communities. An internal evaluation was designed to examine each intervention employed in the health promotion, outreach and diabetes care components of the project. The evaluation will consist of assessing process outcomes such as participation rates in the various interventions. An external evaluation process will assess the effect of the

project in its entirety. This will be measured by determining changes in community health behaviours, diabetes awareness, screening of persons at risk of diabetes, and the care received by persons with diabetes. A variety of evaluation tools including surveys, focus groups and interviews will be used to measure these outcomes. Comparison communities will be identified in order to assess the effect of the interventions on a number of different outcomes.

While the prevention of diabetes and its complications are the ultimate goals of this project, process outcomes have been selected to detect changes in the community during the time frame of the project.

Project DIRECT is one of the first truly community based diabetes primary prevention trials to be conducted. While recognising the limitations of the evidence it was considered sufficient to conduct this comprehensive multifaceted intervention project.

The Sandy Lake Health and Diabetes Project (Ontario, Canada) ³⁵

In 1992 the Sandy Lake Health and Diabetes Project was set up in a small isolated community of approximately 1,600 Oji-Cree Indians, in northern Ontario. The aims of the project were to:

- determine the prevalence of type 2 diabetes and IGT in the community,
- to identify anthropometric, metabolic and lifestyle characteristics associated with NIDDM and IGT, and
- to use ethnographic data collection techniques to aid in the development of culturally appropriate data collection instruments and intervention strategies to modify risk factors for diabetes and its complications.

At present the statistical analysis is still in progress but the work to date does provide valuable insight into the background, methodology and lessons learned in the development and implementation of a community based project. The success of the project has been measured to date in terms of the quality of the relationships with the community and project staff, the

high participation rate and the quality and scope of the data collected. Much of the motivation for this project has been due to concern about the diabetes by the community.

The success of the project at this time is attributed to the co-operation and partnership with political leaders and local community organisations. The high participation rates have been due to the involvement of community members who act as recruiters and data collectors. This has ensured that the project and data collection instruments are culturally appropriate and accepted.

The Kahnawake Schools Diabetes Prevention Project (KSDPP) (Quebec, Canada) ³⁶

This three year type 2 diabetes primary prevention project was set up in the mid 1990s in a small Mohawk community (population approx. 6,746) near Montreal, Canada where 12% of the community have type 2 diabetes. Results of a previous study conducted between 1985 and 1995 revealed that the age of onset of diabetes was decreasing and that the main risk factor in the community, obesity, was increasing among children. As a result of the concern generated by these results this project was developed.

The prevention programme focuses on elementary school children, their families, and the community and uses a number of interventions including a health education programme, recreational activities, and community based activities promoting healthy lifestyles. The short-term aim is to reduce the prevalence of known type 2 diabetes risk factors including obesity, high calorie and high fat diets, and physical inactivity among children aged 6 – 12 years. The long-term aim is to reduce the future occurrence of type 2 diabetes. This it is hoped will be achieved by improving knowledge and attitudes of both children and parents, and by improving the availability of healthy foods and recreational facilities to support healthy behaviour changes.

A number of intervention models have been used to establish the project. The Ottawa Charter for Health Promotion fostering community involvement and ownership underpins the project.

Such an approach is considered important to facilitate maintenance of the project beyond the initial external research funding.

However, at present only the baseline results are available. The evaluation will include longitudinal and cross sectional data collection and analysis of obesity, fitness, eating habits and physical activity of the students. Regular follow up evaluation is planned in conjunction with comparison schools. The evaluation has three main components, outcome, proximal impact, and process evaluation,

- Outcome evaluation examines the relationship between exposure to the program and obesity, fitness, and healthy eating among the school children.
- Proximal evaluation, which is determined by a self-administered questionnaire, considers features such as parental support that impacts on healthy eating and physical activity.
- Process evaluation monitors environmental changes in schools, families and the community.

The high level of participation so far is attributed to the supportive local community, use of local skills and the collaborative participation of the community in the project ensuing cultural requirements are met and woven into the strategies. Success is believed to be more likely as a result of implementing a health promotion approach coupled with a wide variety of interventions incorporating a range of communication styles and techniques.

Zuni Diabetes Prevention Program 37

The Zuni Diabetes Prevention Program is a four year community based primary prevention program to reduce the prevalence of diabetes risk factors among high school youth. The Zuni Indian community has a high prevalence of type 2 diabetes affecting one in three adults over the age of 35 years. Like the previous example the program grew out of community's recognition of diabetes as a problem in their community and their desire to act. The program is aimed at school aged children with joint participation between the University of Arizona and the Zuni Public School District.

The interventions used in this program were aimed at the five identified risk factors present in the community, obesity and pattern of fat distribution, insulin resistance, low physical activity and poor fitness, high consumption of sugar rich beverages, and low consumption of high fibre foods. As a result a number of interventions were set up to target these risk factors. They included the establishment of a supportive environment, construction of a wellness centre, diabetes education integrated into the school curriculum, and modification of the food supply available to the students.

The study was small (only two high schools were targeted) and achieved a low participation rate. Evaluation of the program included multiple cross sectional surveys starting with baseline assessment of height, weight, knowledge, attitudes and beliefs, waist/hip circumference, OGTT, activity, fitness, and dietary recalls.

Some difficulties arose with respect to finding the time to include diabetes education into the curriculum, and in gaining a high level of participation in the wellness fitness centre. The modification of the school food supplied met with limited success as a result of the poor commitment by the research team. Despite these drawbacks a downward trend in BMI was recorded in both males and females over three years but this was not statistically significant. The consumption of high fibre foods increased but this change was not statistically significant, while a significant ($p < 0.05$) decrease in the amount of sugared beverages consumed occurred. Cardiovascular fitness improved significantly ($p < 0.05$) with increased regular physical activity.

Other community trials

Other community-based projects are currently underway including:

- the Quest program prevention trial among Pima/Maricopa youth living in the Gila River Indian Community. ³⁸
- Stockholm Diabetes Prevention Programme (SDPP) ³⁹

Summary

The main distinguishing features of these programmes compared to the epidemiological studies already appraised are that the former generally:

- recognise the key role that community groups play in determining the success of these programs,
- used both high-risk and population strategies,
- in most cases follow the principles of health promotion with a number incorporating the strategies in the Ottawa charter,
- require long-term commitment by health authorities and communities that is necessary to increase the likelihood of achieving long term goals and to sustain the programs over time, and
- each of these programmes have identified populations with a high prevalence of diabetes,
- employs a range of interventions,
- the larger studies, such as Project DIRECT, are committed to run for at least 5 years, and
- while it is too early to detect any long term impact on diabetes care and prevention, they do provide valuable insight into programme implementation, and evaluation methodologies.

5.4 New Zealand primary prevention experiences

This section briefly describes some of the current programmes in New Zealand aimed at preventing diabetes using a range of different strategies. This is followed by an appraisal of several interventions trials conducted here.

New Zealand community prevention initiatives

In New Zealand a number of initiatives have been undertaken looking at controlling and preventing diabetes. They include:

- Research has been conducted to examine the effectiveness of various interventions within communities. These include nutritional education programme surveys⁴⁰ and diabetes prevention studies involving Samoan church communities.⁴¹
- South Auckland Diabetes Trust was set up in 1990 to provide support and programmes for people with diabetes and integrate services. The Trust is active in the area of diabetes prevention by promoting lifestyle changes through community development.³
- The National Heart Foundation has been a leader in promoting healthy nutrition and increased physical activity.³
- The Hillary Commission and the National Heart Foundation launched the “Green Prescription” in 1997 and the “Push Play” program in 1999. The green prescription is aimed at overcoming the barriers to and increasing physical activity.³ Promotional material is available in at least six languages while the delivery of the programme is by general practitioners. The number of general practices using the green prescription has increased from 25% in 1998 to 37% in 1999.⁴² Currently a randomised control trial to assess the effectiveness of a green prescription intervention in increasing physical activity levels in middle aged and older people is being developed. It will also look at the effectiveness of the green prescription in improving health outcomes (measured by a cardiovascular risk index) and its cost effectiveness. Importantly it will look at the factors affecting the uptake of the interventions in patients and general practitioners.⁴³

- The Cancer Society of New Zealand has for a number of years promoted a “Fit Food Campaign”. Reports suggest that this campaign has been effective in increasing the consumption of fruit and vegetables.³
- United Fresh established the “5 + a Day” campaign to promote the consumption of fruit and vegetables using a population strategy.³
- The Ola Fa’autauta Project (Samoan Lifewise Project). This project was set up involving three Samoan churches in Otara, Glen Eden and Glen Innes in recognition of the heavy burden of non-communicable diseases, including diabetes, in the Pacific population. The interventions focused on aerobic sessions, nutrition education and diabetes support and education groups. The project provided valuable experiences relating to the setting up of community centred interventions, building relationships with key members within the communities, and the evaluation procedures using a variety of methods. The evaluation of outcomes is currently in publication.⁴⁴

Intervention trials in New Zealand

A variety of intervention trials have been conducted in New Zealand, some of which are appraised in Table 2. The Samoan church group and Samoan Lifewise Project projects are two community based studies using a combination of education and physical activity interventions.^{41 44} The former has reported success in maintaining weight in those in the intervention group. While the latter is in publication, initial results suggest the interventions incorporated in this project have impacted significantly in terms of weight reduction.⁴⁵ After adjusting for confounders, significant ($p = 0.039$) weight reduction was recorded in the intervention churches (average weight loss 0.4 +/- 0.3 kg) compared to the control church (1.3 +/- 0.6 kg). Vigorous exercise increased by 10% in the intervention groups compared to a 3% reduction among controls ($p = 0.007$). Both these studies are important in that they involve populations with a high-risk of type 2 diabetes.

The Green Prescription program has reported some success in the short term⁴⁶ but no evaluation has been conducted to determine the long-term impact on increasing physical

activity. Furthermore it has not been evaluated in populations or ethnic groups that have the highest risk of type 2 diabetes.

The National Nutrition Survey (1997) while not an intervention trial does highlight dietary deficiencies and the increasing number of New Zealanders considered to be overweight or obese.¹⁶

Summary

- **Currently there are a wide ranges of different health promotion activities being carried out in New Zealand which focus on increasing physical activity and promoting healthy food choices.**
- **Many of the current health promotion initiatives appear to operate in isolation of one another.**
- **There are a number of multi-intervention community based trials involving Samoan groups. These have provided some useful insights into project development in these communities.**

Table 2 Intervention trials and surveys: diet and/or exercise

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Samoan church based study 41	Pilot to evaluate the impact of diabetes related lifestyle programme on diabetes knowledge, exercise and dietary habits, and body size.	222 Western Samoans from two church congregations. One congregation assigned as a control (n = 78) and the other the intervention group (n = 144). 4 diabetes awareness sessions were held and included culturally appropriate information leaflets, a video, flip charts and posters. Information included the nature, symptoms, and long term consequences of diabetes. Exercise sessions, in the first year were weekly then twice weekly in the second year. Cooking demonstrations were also conducted in two blocks of 4 sessions.	Non-randomised intervention trial	2 years	Baseline – diabetes knowledge and behaviour questionnaire (DKB) relating to the nature, symptoms, complications and treatment of diabetes. Also included an assessment of cooking methods. Measures of subjects included weight, height, minimum waist and maximum hip circumference, and OGTT if random glucose ≥ 6.0 mmol/l or a fructosamine ≥ 260 micromol/l. At follow up baseline evaluation repeated as well as an evaluation relating to participation. Response rate (based on intention to treat) was 64% in both groups after 2 years.	<p>Evaluation of the programme showed that the participants found that all aspects of the study programme helpful.</p> <p>The intervention group showed no weight gain, a decrease in waist circumference, increased diabetes knowledge, increased activities and reduced reported dietary fat intake. These changes were all statistically significant when compared to the control group.</p>	Non-randomised. Response rate low. Contamination of the control population occurred.

Table 2 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
The Ola Fa'atauta Project (Lifewise Project) ⁴⁵	To measure the impact of a nutrition education and exercise program on weight in Samoan communities	Samoan church communities in Auckland: 2 intervention n = 365 and 1 control n= 106). Interventions included aerobics sessions and nutrition education about dietary fat over 1 year.	Quasi-experimental design. Three non-randomised Samoan church communities	1 year intervention and 1 year maintenance in one church.	Diet and lifestyle questionnaire which included physical activity. Height, weight, waist and hip measurements and BMI calculated. Blood pressure. All measures were repeated at follow up. Response rate: 81% of the interventions and 66 in the control church.	<p>Compared to controls knowledge of the fat content of food did not increase in the intervention churches.</p> <p>The intervention churches lost an average of 0.4kg of weight. This was significantly different to the average 1.3kg increase in weight in the control church ($p = 0.0039$). Decline in mean hip circumference in the intervention churches (-0.5cm) and this change was significantly different ($p = 0.004$) from the increase in hip circumference in the control church (2.1 cm)</p> <p>There was no significant change in waist circumference or blood pressure.</p> <p>After one year of maintenance the weight loss in the intervention churches had been regained, there was a significant number of people who were sedentary and a decrease in the proportion who were moderately active. The number of people who removed chicken skin and excess fat from meat also declined. However the proportion of people engaged in vigorous activity increased.</p>	

Table 2 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Integrated diabetes project Workwise 40	To assess the effects of community based interventions on the nutrition knowledge, diabetes awareness including risk factors, and access to diabetes services, acceptability of education resources, and the knowledge and skills of practice nurses.	Interventions included: Community nutrition education targeting Maori and Pacific people, organisations and individuals. Education in the community on nutrition and cooking. 7 Maori and Pacific Island nutrition programmes were assessed. Education used pamphlets and video resources. General practice intervention aimed at practice nurses. Display information was sent to 12 general practices with a total of 32 nurses) in North Shore to improve the consistency and accuracy of nutrition messages including diabetes risk factors, and to see if these affected the messages delivered to the public. Supermarket intervention. 70 participants. Nutritional displays at 2 supermarkets (Birkenhead and Northcote). 79 participants. Aim was to assess if changes had occurred in eating, cooking and purchasing behaviours. Takeaways intervention. One day course on optimal cooking techniques aimed at lowering fat content of fried foods and assess changes made. Butchery intervention. 8 butcheries were targeted for a course in reducing the fat content of meats.	Non-randomised intervention trial.	Variable depending on the intervention	Pre- and post self-reported changes determined by questionnaire.	Community nutrition education programme showed poor pre intervention knowledge for diabetes risk factors, food to eat, and signs of diabetes. Post intervention the proportion able to identify risk factors (27%), signs of diabetes (60%) and the "foods to eat most" (54%). The interventions increased practice nurse confidence and skills when dealing with nutritional issues. Supermarket intervention found that the displays had prompted respondents to change their eating, shopping and cooking practices. More were eating fruit and vegetables and other foods promoted in the display. Takeaways intervention. 7 (78%) indicated they had changed cooking methods. Butchery intervention showed that the sale of low fat mince had increased. The lack of randomisation, small sample numbers, and other methodological flaws reduces the confidence in the conclusions drawn from these interventions.	Small sample sizes for each intervention. Not randomised

Table 2 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Green Prescription Study 1998 46	To determine if written advice from a general practitioner increases physical activity more than verbal advice alone	Study undertaken in two urban areas – Auckland and Dunedin. 37 general practitioners were selected. Inclusion criteria: only patients not already physically active and who were thought most likely to benefit from physical activity were selected to take part. Participants (n = 491) were then assigned randomly to receive either written (n = 239, green prescription) or verbal (n = 252) instructions relating to physical activity. Exclusion criteria ill defined.	Randomised control trial	6 weeks. Follow up by trained blinded interviewer by phone. 35 participants were lost to follow up	Baseline data relating to current level of physical activity was established prior to randomisation. Reassessed at end of study	Average age of participants was 49 years. 79% of cases were encouraged to increase walking. The change in the number of subjects participating in any recreational exercise was significantly greater in those receiving written instructions ($p < 0.01$). There was no significant change in the amount of physical activity over the study period between the two groups ($p = 0.06$). No change was observed in the duration of activity between the groups. Self reported participation in physical activity to maintain health and fitness increased from 36% to 68% in the green prescription group and was significantly different to the control group ($p = 0.02$). Study duration too short to determine if long term benefits are achievable.	Uncertain if it is possible to generalise to the population at risk of diabetes in terms of effectiveness in Maori and Pacific people. GPs made a subjective decision as to which individuals were included in the study. Different interviewers administered the pre and post intervention questionnaires. Pre-intervention was face to face. Post-intervention was conducted by phone. Study duration short.

Table 2 continued...

Study	Purpose of study	Sample and Interventions	Study design	Study period	Data collection tools and outcome measures	Findings	Study limitations
Green Prescription Study 1997 47	To assess the attitude and perceptions of GPs towards the practice of writing green prescriptions	25 general practitioners participated in discussion focus groups	Focus groups – qualitative	2 week period	All GPs were attended training sessions on the benefits of exercise, and how to prescribe it, an exercise assessment sheet and green prescription pad. Follow up was conducted by a trained facilitator. Each focus group lasted 90 – 120 minutes. 6/10 GPs in Auckland attended the focus group, 7/27 and 12/23 attended two focus groups in Auckland.	GPs felt comfortable writing an exercise prescription. The time needed to discuss and prescribe exercise were identified as the main barriers to the prescription of exercise. GPs felt that writing out a prescription added weight to their verbal advice. GPs also felt that their efforts would be more effective if they were supported by wider measures such as national media campaigns promoting physical activity.	Response rate among GPs low.
New Zealand National Nutritional Survey (NNS97) 16	To provide information on the food and nutrient intakes, dietary habits and nutrition related clinical measures of New Zealanders.	4,636 New Zealanders in selected households and aged > 15 years.	Survey	1997	Data collected included 24 hour diet recall, a self-administered qualitative food frequency questionnaire which estimated the frequency of intake of foods over the preceding 12 months and included questions on food preparation habits, dietary supplements, barriers to dietary change and physical measurements including weight, height, three circumferences, two skin folds and elbow breadth, blood sample for cholesterol and iron status determination.	Both men (23 g/day) and women (18 g/day) are taking in less than the recommended daily intake of fibre (25 – 30 g/day). 17% of adult New Zealand population were considered obese (15% males, 19% females). Mean body weight has increased by 3.2 kg since 1989.	

6 Current approaches to type 2 diabetes prevention

The appraisal of the literature demonstrates that our knowledge of the primary prevention of type 2 diabetes is primarily based on epidemiological studies with only a small number of community based programmes currently in progress. Intervention strategies to prevent type 2 diabetes are aimed at measures that decrease insulin resistance and promote and sustain beta-cell function. The current evidence supports interventions that reduce obesity and increase physical activity. This is consistent with recommendations by WHO which supports prevention programmes that include interventions aimed at reducing obesity, fat intake, and increasing physical activity. ⁶

The translation of these successes into the community is influenced by factors not usually incorporated into epidemiological studies. Social, cultural and practical considerations also play an important part in determining the degree of success a community based prevention programme achieves. ^{10 48} Similarly these factors are critical in determining the level of support from within the community and whether this support will be ongoing.

Existing evidence shows that weight control and physical activity are suitable end-points for well evaluated population based primary interventions rather than waiting for definitive studies using the incidence of type 2 diabetes as the end-point. ²⁰

A number of community based primary prevention programmes have been outlined, however none have published their results at this time. Each programme provides important insight into their development, implementation and evaluation processes, as well as describing the features which are believed to be vital to their success. The most important feature of these programmes is the early and ongoing involvement of community representatives at each of these stages.

Such approaches are consistent with objectives promoted by the Ministry of Health “to reduce the prevalence, disability and death rates from diabetes mellitus”.³ By applying these principles it may be possible to reduce the rate of increase in type 2 diabetes. A further aim is to reduce the numbers of people with impaired glucose tolerance developing diabetes and those with diabetes from developing complications leading to disability or premature death.

The Ministry also identified the need to develop strategies that³:

- reduce and prevent obesity
- increase physical activity
- reduce the consumption of dietary fat, especially saturated fat
- increase consumption of dietary unrefined carbohydrate, including soluble fibre.

This approach is consistent with the evidence presented here.

It is likely that strategies to prevent type 2 diabetes will also prevent gestational diabetes mellitus (GDM). Not only does GDM progress to type 2 diabetes in about 50% of women (about 25% of whom probably had type 2 diabetes prior to their pregnancy) but the intra-uterine environment is important in contributing to rates of obesity and type 2 diabetes in the next generation.

7 Evaluation of community diabetes primary prevention programmes

As community based primary prevention projects are not readily amenable to controlled, randomised studies and frequently include multiple interventions, they are difficult to evaluate with the same degree of rigour that may be applied to therapeutic trials. Other methods of evaluation are required which consider both short and long-term outcomes of primary prevention programmes. Each of the community projects appraised here recognise the importance of evaluation and have incorporated various methods to achieve this.

As the overall aims of these projects have been to prevent diabetes the long-term health indicators used in these studies have included prevalence and incidence of both type 2 diabetes and IGT. WHO (1994) also recommends the collection of a number of other important variables including the determination of insulin resistance as indicated by blood lipids, blood pressure; fasting plasma insulin concentrations and/or insulin sensitivity. ⁶

Short-term measures of programme performance used in a number of the community and epidemiological trials have included the monitoring of known risk factors such as weight (BMI), fat distribution, levels of physical activity, dietary and other lifestyle factors. Proxy indicators for biological outcomes have included assessment of knowledge relating to diabetes and diabetes risk factors, diet, and food preparation.

It is important that the reassessment of these measures be done on completion of the project and at regular intervals during the course of the programme to measure its effectiveness. The main health outcome indicators requiring reassessment include those mentioned above as well as the rate of reversion of individuals with diabetes or IGT to normal glucose tolerance where longitudinal follow up is part of the intervention programme. A reference or control population would also be required for comparative purposes.

The above measures do not however identify why a particular intervention is successful or not. ²⁰ Therefore other methods of evaluating the interventions themselves need to be employed to determine their acceptability and feasibility. Evaluation of this kind will provide feedback which can be used to refine interventions and for ongoing project development. As primary prevention community projects are likely to require long-term investment before measurable health outcomes can be detected, this form of evaluation recognises that process outcomes are indicators of early progress. Thus a comprehensive programme evaluation will require a combination of both quantitative and qualitative methods, as well as careful economic evaluation.

8 Recommendations

Based on the current evidence the following are a set of recommendations supporting the establishment of a type 2 diabetes primary prevention programme in Auckland. It is recommended that the programme:

- be community based, incorporating multiple interventions, and targeting a high risk population,
- targets the entire population including those currently at low risk such as pre-school and school students,
- should consist of three arms
 - Health promotion – through environmental and lifestyle changes, encouraging people to increase physical activity and reduce fat and energy intake,
 - Outreach – raising awareness about diabetes risk factors, signs and symptoms and complications among high risk communities, promoting screening of all antenatal women and opportunistic screening to identify previously undiagnosed diabetes,
 - Care - encouraging better self-care and better health professional care of diabetes, (through greater integration of care at the primary/secondary care interface, enhanced surveillance of health indicators and outcome measures, and purchasing strategies that reward best practice),
- be evaluated. It will be necessary to determine evaluation processes, goals, methodologies, and the timing of reporting,
- develop strong connections with communities and those working within these communities, so as to stimulate sustained change in individual behaviour patterns at a community level. This will require an understanding of the cultural and social environment of each community and the application of a community development model,
- continue to build on the existing relationships between New Zealand and other groups working on type 2 diabetes primary prevention programmes, for example Auckland Healthcare Services and the USCDC-sponsored programme Project DIRECT in North Carolina,

- utilise existing health promotional skills, networks and expertise developed by other community projects such as the Meningococcal Awareness Programme,
- identify and include at all stages of development those groups involved in existing diabetes services and key community leaders in the intervention area. Also included should be local general practitioners and other health providers, dietary services, and organisations with an active interest in the control of body weight and physical activity. These groups should actively participate in the planning, management and implementation of the project,
- integrate with other intervention programmes such as the Green Prescription initiative,
- be co-ordinated with existing primary, secondary and tertiary diabetes care services, so as to build on the existing diabetes care infrastructure, and
- involve representatives from the transport and food industries, education sector and local government, as part of an inter-sectoral collaborative group to facilitate environmental change.

9 Conclusion

In New Zealand a 30% increase in the prevalence of type 2 diabetes on 1998 levels is expected by the year 2006 assuming no increase in incidence rates. Much of the diabetes burden occurs in Maori and Pacific people who have much higher rates of diabetes than the European population. It is unlikely that secondary and tertiary care services will be able to cope with the increasing number of diabetics predicted in the absence of programmes aimed at preventing type 2 diabetes.

Epidemiological studies have consistently shown the benefits in terms of reducing the incidence of diabetes by reducing obesity and increasing physical.

A number of community based primary prevention programmes are currently underway overseas. Until these programmes have been evaluated, there will be a lack of evidence on their effectiveness in reducing the prevalence of type 2 diabetes in the population. Despite this there is sufficient evidence to justify the investment in community based primary prevention programme in Auckland.

The combination of high-risk and population based strategies would be the most effective approach to any prevention programme in Auckland given the easily identifiable "at risk" populations. A number of studies already conducted in these populations provide evidence for the effectiveness of the various interventions employed. The involvement of community groups and those working within the field of diabetes is vital for the success of any programme. Initially the programme should be conducted as a pilot with a control population for comparative purposes.

The question may not be can we afford to invest in a primary prevention programme but rather can we afford not to?

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