Diet in the prevention of Type 2 Diabetes

Dr Michelle McKinley
Centre for Public Health
School of Medicine, Dentistry & Biomedical Science
m.mckinley@qub.ac.uk

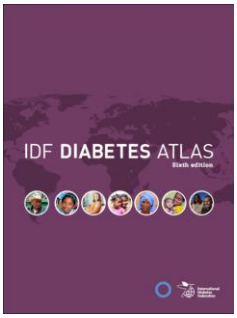
Queen's University Belfast

Presentation Outline

- Background
- Prevention of Type 2 Diabetes Mellitus
- Role of diet in prevention of T2DM
  - Nutrients
  - Food groups
  - Whole diet approaches
- Conclusion

Background

IDF Diabetes Atlas

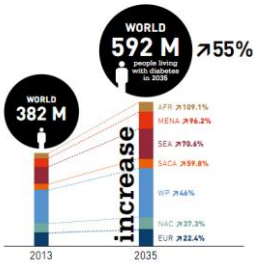


Diabetes prevalence, mortality and health expenditure for 2013 and 2035

International Diabetes Federation

http://www.idf.org/diabetesatlas

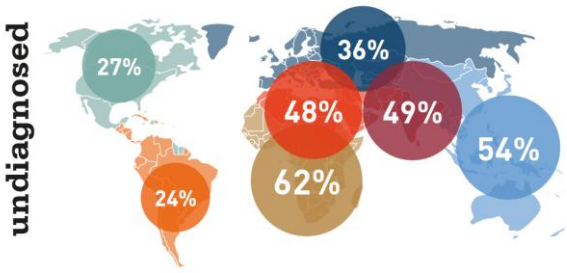
The global burden



382 million people have diabetes

By **2035**, this number will rise to **592 million**

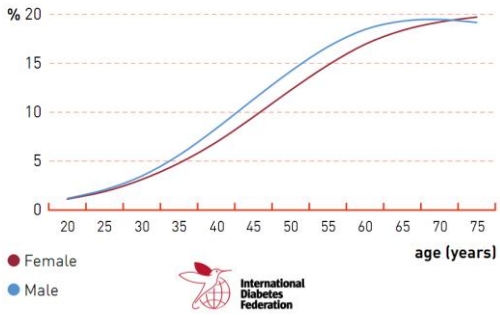
International Diabetes Federation



Proportion of cases of diabetes (20-79 years) that are undiagnosed, 2013

International Diabetes Federation

Figure 2.2 Prevalence (%) of people with diabetes by age and sex, 2013



International Diabetes Federation

Childhood diabetes in the UK

Type 2 diabetes in UK children: an emerging problem

Etishham et al. Diabetic Medicine 2000; 17: 867-871

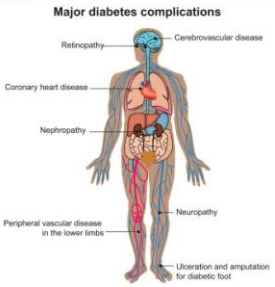
The first cases of type 2 diabetes in children in UK - overweight girls 9-16y of Indian, Pakastani or Arabic origin

Type 2 diabetes in obese white children

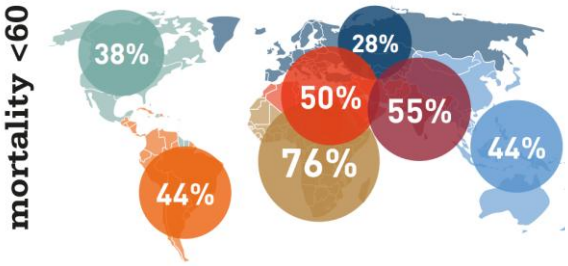
A J Drake, A Smith, P R Betts, et al.

Arch Dis Child 2002 86: 207-208
doi: 10.1136/adc.86.3.207

Major diabetes complications

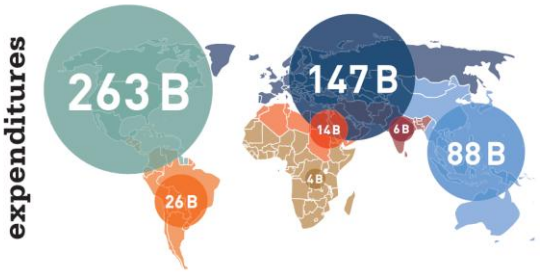


- Leading cause of **blindness** in working age adults
- Leading cause of non-traumatic **lower limb amputations**
- Leading cause of end-stage **kidney disease**
- Two to four fold increase in **CV mortality and stroke**



Proportion of deaths due to diabetes in people under 60 years of age, 2013

International Diabetes Federation



Health expenditure (USD) due to diabetes (20-79 years), 2013

International Diabetes Federation

Prevention of T2DM

Types of diabetes

Type 1 diabetes

- Lack of insulin
- Autoimmune
- Usually children

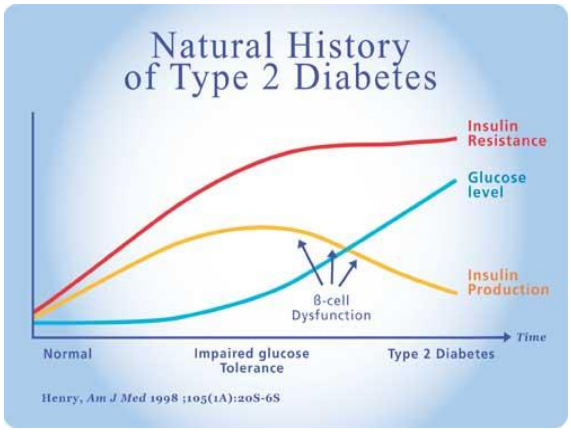
Type 2 diabetes

- Insulin resistance
- Lifestyle factors
- Usually adults

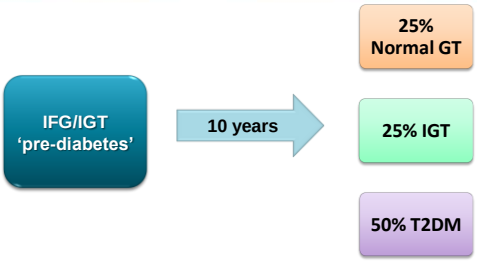
Gestational diabetes

- Insulin resistance
- During pregnancy
- Risks to mother and child

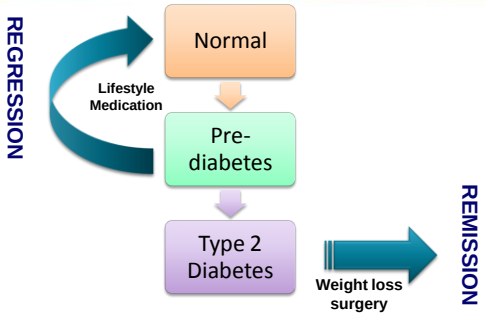
International Diabetes Federation

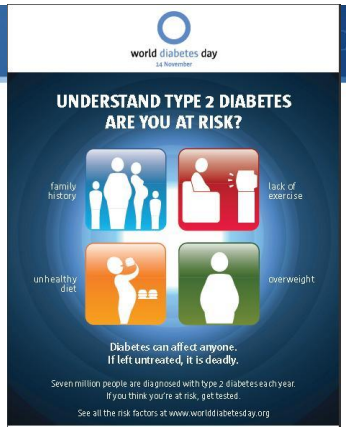


Progression of pre-diabetes to T2DM



Progression from pre-diabetes to T2DM is not inevitable





The Diabetes Prevention Program

- Major US clinical trial to determine whether diet and exercise or the oral diabetes drug metformin could prevent or delay the onset of T2DM.
- Participants (n=3234):
  - Adults at high risk for type 2 diabetes (IGT)
  - Mean age 51 years
  - Mean body mass index (BMI) 34

DPP Research Group. N Engl J Med 2002;346:393-403

The Diabetes Prevention Program

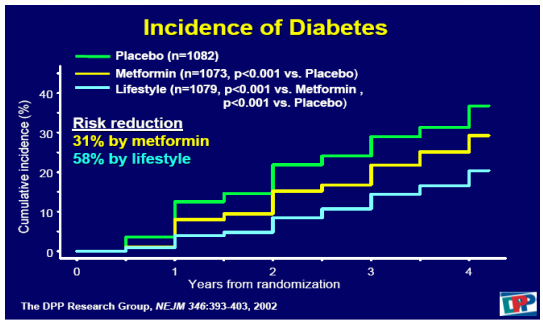
Lifestyle intervention | Metformin | Placebo

5-7% weight loss
Healthy energy-restricted, low-fat diet
30 mins physical activity x 5 days/week
Behaviour change modification

DPP Research Group.
N Engl J Med 2002;346:393-403

The NEW ENGLAND JOURNAL of MEDICINE

The NEW ENGLAND JOURNAL of MEDICINE



Ten-year follow-up of DPP

Lifestyle intervention
- reduced the rate of developing type 2 diabetes by **34%** *vs* placebo
- delayed type 2 diabetes by about **4 years** compared with placebo

Metformin
- reduced the rate of developing type 2 diabetes by **18%** *vs* placebo
- delayed type 2 diabetes by **2 years** compared with placebo

DPP Research Group. The Lancet 2009: Vol.374, No. 9702.

Diabetes prevention trials - Overall

- Five RCTs in individuals at high risk of T2DM.
- Lifestyle interventions have an effect in delaying or preventing progress to diabetes in people with pre-diabetes.
- Lifestyle interventions seem to be at least as effective as pharmacological interventions.
- A combination of diet and exercise may be more beneficial that either diet or exercise alone.

Gillies, et al, BMJ 2007

Role of diet in the prevention of T2DM

Role of diet in prevention of T2DM

- **Individual nutrients**
  - Vitamin D
- **Food groups**
  - Fruit and vegetables
  - Dairy
- **Whole diets**
  - Dietary patterns
  - DASH diet
  - Mediterranean diet

Vitamin D

Vitamin D

- Food
- Supplements
- Sun (April – September)

Estimated 50% people in UK have sub-optimal vitamin D status (< 50 nmol/l)

1 in 6 people deficient (<25nmol/l)

National Diet and Nutrition Survey

REPORT BRIEF NOVEMBER 2010

INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

Advising the nation / Improving health

For more information visit www.iom.edu/vitamind

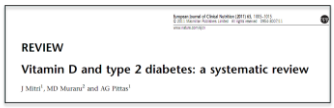
Dietary Reference Intakes for Calcium and Vitamin D

NIH Public Access
Author Manuscript
J Clin Endocrinol Metab. Author manuscript; available in PMC 2007 November 21.

Published in final edited form as:
J Clin Endocrinol Metab. 2007 June ; 92(6): 2017–2029.

The Role of Vitamin D and Calcium in type 2 diabetes. A systematic Review and Meta-Analysis

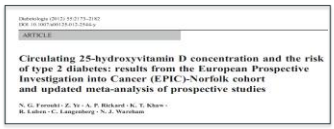
ANASTASSIOS G. PITTAS, MDMSc[1], JOSEPH LAU, MD[2], FRANK HU, MD[3], and BESS DAWSON-HUGHES, MD[1,4]



REVIEW

Vitamin D and type 2 diabetes: a systematic review

J Mitri[1], MD Muraru[2] and AG Pittas[1]



ARTICLE

Circulating 25-hydroxyvitamin D concentration and the risk of type 2 diabetes: results from the European Prospective Investigation into Cancer (EPIC)-Norfolk cohort and updated meta-analysis of prospective studies

N. G. Forouhi · Z. Ye · A. P. Rickard · K. T. Khaw · R. Luben · C. Langenberg · N. J. Wareham

RCT evidence

- Indicates that insulin-resistant populations with sub-optimal vitamin D status are most likely to benefit from vitamin D supplementation.
- An improvement in HOMA-IR and postprandial insulin sensitivity has been observed in preliminary studies in such populations.

DIR study design

- **Double blind randomised placebo controlled trial**
  - **Pre-diabetes (IFG/IGT)**
  - **Suboptimal** Vitamin D status (≤50nmol/l)
  - **3,000 IU (75 µg)** Vitamin D_3 daily for **6 months**
  - ***Primary endpoint*** **-** insulin resistance as measured by euglycaemic-hyperinsulinaemic clamp
  - ***Secondary endpoints*** **-** blood pressure; pulse wave velocity, inflammatory markers

HSC Public Health Agency
HSC Research and Development

Chest Heart & Stroke

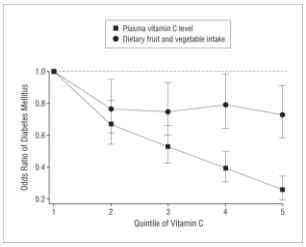
Food groups:

Fruit & Vegetables

The JAMA Network

From: **Plasma Vitamin C Level, Fruit and Vegetable Consumption, and the Risk of New-Onset Type 2 Diabetes Mellitus: The European Prospective Investigation of Cancer–Norfolk Prospective Study**

Arch Intern Med. 2008;168(14):1493-1499. doi:10.1001/archinte.168.14.1493



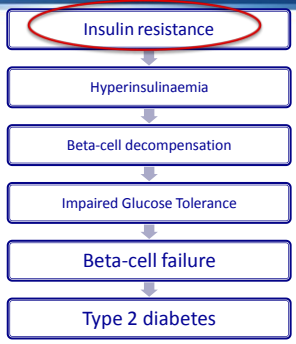
Dose-Response Effect of Fruit and Vegetables on Insulin Resistance in People at High Risk of Cardiovascular Disease

A randomized controlled trial

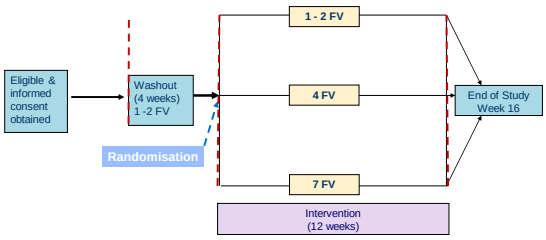
Ian R. Wallace, mrcp[1]
Claire T. McEvoy, phd[1]
Steven J. Hunter, frcp[2]
Lesley L. Hamill, phd[1]
Cieran N. Ennis, bsc[1]
Patrick M. Bell, frcp[2]
Chris C. Patterson, phd[1]
Jayne V. Woodside, phd[1]
Ian S. Young, frcp[1]
Michelle C. McKinley, phd[1]

American Diabetes Association. Diabetes Care 2013;36:3888-96

FOOD STANDARDS AGENCY



Study Design



Primary endpoint :
insulin resistance assessed by euglycaemic-hyperinsulinaemic clamp (EHC

Implementation of intervention

- Participants asked to:
  - Maintain body weight
  - Minimise other changes to health and lifestyle behaviours
- All participants received **weekly free home deliveries of FV** according to their randomisation
  - **free choice of FV** - no prescriptive list…. but participants encouraged to consume as wide a variety of FV as possible

Results

- FV intake (4-day food diaries) significantly different between the groups:
  - final FV intake (in portions/day) according to group allocation: 1.7 (1-2FV), 3.8 (4FV), 7.0 (7 FV)
- Biomarkers: Significant increase in some carotenoids indicating increased FV intake
- Weight maintained during intervention
- No significant effect on insulin resistance
- In overweight people at high risk of cardiovascular disease in whom weight is maintained increased FV intake had no significant effect on insulin resistance.

Still unknown.....

Is type of FV the key?

Is it fruit or veg or both?

Is variety important?

Food groups:

Dairy Foods

Dairy and risk T2DM

- Observational studies show a consistent inverse relationship between dairy intake and prevalence of IRS and T2DM
- Systematic review of observational evidence:
  - Highest dairy intake (3-4 servings per day) had a 29% lower risk of developing IRS compared to the lowest intake (0.9-1.7 servings per day)

(Tremblay & Gilbert et al. J Am Coll Nutr 2009;28 Suppl 1:91-102S)

European Journal of Clinical Nutrition (2011) 65, 1027–1031

www.nature.com/ejcn

ORIGINAL ARTICLE

Dairy consumption and risk of type 2 diabetes mellitus: a meta-analysis of cohort studies

X Tong, J-Y Dong, Z-W Wu, W Li and L-Q Qin

Dairy and risk of T2DM

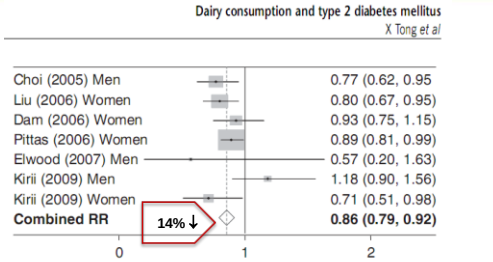


Figure 1 Estimated RRs (highest versus lowest category) of T2DM associated with dairy products consumption. Tests for heterogeneity between all studies, $Q = 8.53$, $P = 0.20$, $I^2 = 29.7\%$.

Tong et al, EJCN 2011

Dairy and risk of T2DM

Table 2 Summary of the relative risk for milk and/or dairy food consumption and T2DM

Item	*Number of cohort studies*	*Combined RR*[a]	*95% CI*
Dairy products	6	0.86	0.79–0.92
Low-fat dairy foods	3	0.82	0.74–0.90
High-fat dairy foods	3	1.00	0.89–1.10
Whole milk	5	0.95	0.86–1.05
Yogurt	4	0.83	0.74–0.93

[a]RR and CI extracted from these studies compared the highest with the lowest quantile of consumption and reflected the greatest degree of control for confounders.

Tong et al, EJCN 2011

Whole diet:

Dietary Pattern Analysis

Dietary pattern analysis

- Dietary pattern analysis represents a new direction in nutritional epidemiology:
  - People eat a wide variety of foods, and thus a complex combination of nutrients
  - .....these foods may have interactive or synergistic effects on the investigated health outcome
  - Dietary pattern analysis allows examination of the combined effects of nutrients and foods on markers of health

Dietary patterns and risk T2DM

'A posteriori' dietary patterns are related to risk of Type 2 Diabetes: Findings from a systematic review and meta-analysis

McEvoy CT, Cardwell CR, Woodside JV, Young IS, Hunter SJ, McKinley MC
(In Press)

Journal of the Academy of Nutrition and Dietetics
The premier source for the practice and science of food, nutrition, and dietetics
Formerly the *Journal of the American Dietetic Association*

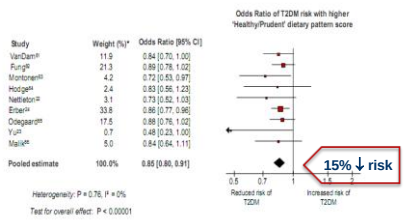
- Cross-sectional and prospective studies included
- The majority of studies had labeled their patterns:
  - **'Healthy/Prudent'** to describe patterns perceived to have generally healthy characteristics and
  - **'Unhealthy/Western'** to describe those patterns perceived to have generally less healthy characteristics
- We used this terminology to categorise the dietary patterns for the purposes of the meta-analysis

Western Vs Prudent dietary patterns

- The 'Unhealthy/Western' DP was characterized by high factor loadings for foods such as meat, processed meat, refined grains, sweets/sugary drinks and fried foods.
- The 'Healthy/Prudent' DP tended to have high factor loadings for foods such as fruit, vegetables, legumes, low-fat dairy, whole grains, fish and poultry.

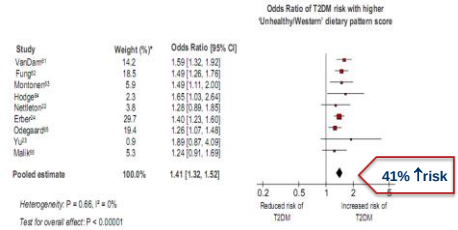
Healthy/Prudent patterns and risk

Figure 2: Forest plot of prospective studies comparing the highest with the lowest category of 'Healthy/Prudent' FA-derived dietary patterns and risk of Type 2 Diabetes Mellitus after adjustment for covariates.



Unhealthy/Western patterns and risk

Figure 3: Forest plot of prospective studies comparing the highest with the lowest category of 'Unhealthy/Western' FA-derived dietary patterns and risk of Type 2 Diabetes Mellitus after adjustment for covariates.



Conclusion

DPs are consistently associated with risk of T2DM even when other lifestyle factors are controlled for.

Whole diet:

DASH Diet

DASH diet

Low in saturated fat, cholesterol, and total fat

Focuses on fruits, vegetables, and fat-free or low-fat dairy products

Is rich in whole grains, fish, poultry, beans, seeds, and nuts

Contains fewer sweets, added sugars and sugary beverages, and red meats than the typical American diet

DASH diet and risk T2DM

Nutrition 29 (2013) 939–947
Contents lists available at ScienceDirect
Nutrition
journal homepage: www.nutritionjrnl.com
ELSEVIER

Review

Effects of Dietary Approaches to Stop Hypertension (DASH) diet on some risk for developing type 2 diabetes: A systematic review and meta-analysis on controlled clinical trials

Fatemeh Shirani Ph.D. Cand.[a,b], Amin Salehi-Abargouei Ph.D. Cand.[a,b], Leila Azadbakht Ph.D.[a,b,*]
[a] Food Security Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[b] Department of Community Nutrition, School of Nutrition and Food Science, Isfahan University of Medical Sciences, Isfahan, Iran

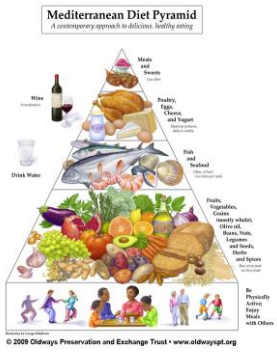
Results

- Aim – to examine effect of DASH on indices of glycaemic control
- DASH Can significantly reduce fasting insulin (7 studies)
- No effect on fasting plasma glucose (9 studies) or HOMA-IR (4 studies)
- Conclusion – the DASH dietary pattern may lead to an improvement in insulin sensitivity independent of weight loss

Shirani et al 2013

Whole diet:

Mediterranean Diet



- Largely based on fruit, vegetables, wholegrain cereals, nuts.
- Moderate amounts of fish and dairy products.
- Small amounts poultry and meat.
- Olive oil is the main fat source.
- Wine in moderation.

Observational evidence

- **Two prospective studies:**
- Spanish University graduates, n=13380, followed up for about 4.4 years – highest adherence to Med Diet had 83% lower risk of diabetes compared to lowest adherence.
- Italian MI patients, n=8291, followed up for 3.5 years – Med diet protected against new diabetes (OR 0.65 Highest vs lowest quIntile).

Martinez-Gonzalez et al. BMJ 2008;336:1348-51..
Mozaffarian et al. Lancet 2007;370:667-675..

PREDIMED and risk T2DM

Reduction in the Incidence of Type 2 Diabetes With the Mediterranean Diet

Results of the PREDIMED-Reus nutrition intervention randomized trial

Salas-Salvado et al
Diabetes Care 34:14–19, 2011

PREDIMED

High-risk T2DM
Randomised

Control (low-fat diet)	MD with olive oil	MD with nuts

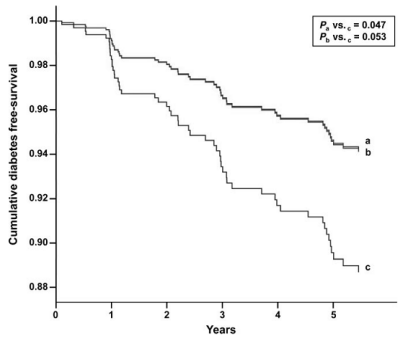


Figure 1—*Cumulative diabetes free-survival by group of intervention. Cox regression models with outcome of diabetes onset and exposure to MedDiet intervention group vs. control diet group, adjusted by sex, age, baseline energy intake, BMI, waist circumference, physical activity, smoking status, fasting serum glucose, use of lipid-lowering drugs, Mediterranean diet score, and weight change during the study. a, MedDiet and virgin olive oil group; b, MedDiet and nuts group; c, control diet group.*

PREDIMED–Reus conclusion

- Med Diet without calorie restriction was effective in the prevention of diabetes in subjects at high risk of CVD.
- Diabetes risk reduction occurred in absence of significant changes in weight or physical activity

- Diabetes prevention trials:
  - Weight loss & physical activity
  - Weight loss was a key factor in reducing incidence of T2DM

Encouraging adoption of the Mediterranean Diet in a Northern European population

- Explore feasibility of peer support as a strategy to encourage adoption of the MD in those at high risk of CVD.
- Peer support intervention, will be developed through direct interaction with the intended target group and then pilot tested.

National Prevention Research Initiative, commenced October 2012
Woodside, McKinley, Young, Kee, Cupples, Prior

MRC Medical Research Council

Conclusion

Conclusion

- Lifestyle interventions are as effective as pharmacological interventions for prevention of T2DM.
- However – at present no universal dietary strategy to prevent diabetes or delay its onset.
- Ongoing trials will help inform the evidence base in this area.

Conclusion

- **Best strategy:**
  - Maintenance of healthy body weight.
  - Generally healthy/prudent dietary pattern – higher intake.
  - Mediterranean dietary pattern (rich in olive oil, fruit and veg, includes whole grains, pulses, nuts and low-fat dairy, moderate alcohol/red wine.
  - Appropriate level of physical activity.
- **The challenge:**
  - to develop public health approaches to support individuals to adopt and maintain lifestyle habits that will reduce the risk of diabetes.