DETECTION AND EARLY LIFESTYLE INTERVENTION IN THOSE AT RISK OF TYPE 2 DIABETES

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ABSTRACT

The prevalence of Type 2 diabetes mellitus (T2DM) has reached epidemic proportions in recent years. It is now widely recognised that T2DM is a highly preventable disease. This article highlights the evidence to date for the prevention of T2DM. In order to prevent or delay the onset of T2DM, people at high risk of developing the condition need to be identified and treated using evidenced-based and cost-effective approaches. Risk scores offer a quick, simple way of identifying those at high risk for invitation to screening programmes without the need for initial invasive tests. Best practice guidance, including those from National Institute for Health and Clinical Excellence (NICE) in the UK and the European wide IMAGE project, recommend that a two-stepped approach whereby the identification of a high-risk status through risk score technology is confirmed by a blood test. Once identified, those at high risk can be offered a lifestyle intervention programme. Landmark diabetes prevention studies show that lifestyle intervention, focusing on increases in physical activity, improvements in diet, and reductions in weight, reduces the risk of progression to T2DM by 30-60% and can have lasting benefits after the active intervention ceases. Recent pragmatic prevention programmes also demonstrate encouraging results. However, research targeted to the prevention of T2DM must continue to be expanded to find the most effective methods of T2DM prevention in various societies and cultural settings. There is also a need for research focusing on young people at high risk and novel approaches, such as targeting a reduction in sitting and use of technology, to support behaviour change.

Keywords: Type 2 diabetes, prevention, high risk, lifestyle, risk score.

INTRODUCTION

An estimated 366 million people worldwide have diabetes, which is expected to rise to 522 million by 2030,1,2 with death rates attributable to diabetes doubling between 2005 and 2030.3 Prevention of Type 2 diabetes mellitus (T2DM) is therefore a public health priority. In order to prevent or delay the onset of T2DM, people at high risk of developing the condition need to be identified and treated using evidenced-based and cost-effective approaches. This article will highlight the latest evidence for the prevention of T2DM.

Identification

Glucose is a continuum and there is a (clinically important and much researched) high-risk state where glucose levels are elevated but not over the threshold for the diagnosis of T2DM. There are a number of invasive tests, for example HbA1c or fasting blood glucose, that can be used to identify those at high risk of T2DM. Impaired Glucose Regulation (IGR) is a high-risk state where impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG) have been identified using an oral glucose tolerance test.4 Individuals with IGR are significantly more likely to develop T2DM than
those with normal blood glucose levels; estimates of progression to T2DM within a year suggest those with isolated IGT have >5-times the risk, those with isolated IFG have 7-times the risk, and those with both IGT and IFG have >12-times the risk compared to normoglycaemic individuals.5 There are now also recommendations that HbA1c levels raised above normal levels, but not in the range for a diagnosis of T2DM, should be classified as at high risk of diabetes.6,7 However, there is no agreed consensus on the HbA1c range that should be classified as at high risk of diabetes, with the International Expert Committee and the UK-based National Institute for Health and Clinical Excellence (NICE) recommending it should be 6.0-6.4% (42-46 mmol/mol), whereas the American Diabetes Association suggests 5.7-6.4% (39-46 mmol/mol).8-10 Follow-up studies have shown similar rates of progression to diabetes from the HbA1c defined as the high-risk state as seen for IFG.11

**RISK SCORES**

Risk scores offer a quick, simple way of identifying those at high risk. The EU-wide IMAGE project recommended the use of risk scores for identifying those at risk of T2DM.12 Risk scores generally follow one of two approaches: either being applied as questionnaires to the individual being assessed – ‘self-assessment’ - or as a query to a general practice database where all those ‘at risk’ are identified using routinely stored data. The Finnish Diabetes Risk Score (FINDRISC) is an example of a self-assessment for predicting the risk of future diabetes; it includes eight questions: age, body mass index (BMI), waist circumference, blood pressure, history of high blood glucose, family history of diabetes, physical activity, and consumption of vegetables, fruits, or berries.13 An example of a risk score which uses routinely stored data is the UK Leicester Practice Risk Score (LPRS). This score, with accompanying software applications, ranks all individuals within a given primary care dataset for their diabetes risk status based on age, sex, ethnicity, family history of diabetes, BMI, and antihypertensive use.14 Scores can also be categorised based on the outcome they predict. Scores which have been developed using cross-sectional data can predict prevalent disease; the LPRS detects current undiagnosed IGR and T2DM, in contrast with scores which have been developed using longitudinal data, where incidence can be predicted, such as FINDRISC. The scores developed to date tend to be for a specific population as studies have found that scores which have been developed elsewhere and used on a different population tend to have low validity.15,16

The PREDICT-2 group have summarised the currently available risk scores worldwide, and this is hosted on the International Diabetes Federation website (http://www.idf.org/risk-prediction-tools-predict-2).17 A number of risk scores have been developed for use in Europe and these are summarised in Table 1. Additionally, the FINDRISC has been validated for use in Greece, Bulgaria, Italy, Spain, and Sweden. Although many risk scores exist,18-21 relatively few are currently used in practice.22 One review stated that this could be because the way in which the risk score will be used is not considered in the development stage.20 A systematic review of the implementation of risk scores reported a number of barriers to the uptake of risk scores by healthcare professionals which included: attitudes toward the tools; impracticality of using the tools; and lack of reimbursement and regulatory support. As previously introduced, the LPRS was derived for population level screening within primary care.14

The developers of this tool have tried to overcome these barriers by developing a piece of software which runs alongside the practices’ electronic medical records to make the score easy to use, in practice. This software was used across 54 general practices in two large prevention studies23,24 where it was used to identify and invite the top 10% at highest risk within each practice for screening.25 Of the 21,741 invited, 4,282 attended (20%). Of these, 25.7% were found to have IGR, with 4.2% having undiagnosed T2DM. These rates were significantly higher than when a population screening approach was taken in the same vicinity.26 This risk score also has regulatory support and is recommended by NICE.27 Risk scores incorporating invasive measures also exist, i.e. biomarkers or genetic factors.28 These generally do not out-perform their non-invasive counterparts and are not routinely used. Using non-invasive risk scores allows people to assess their own risk, and therefore might engage people who do not routinely visit their GP.

**Stepped Approach**

Best practice guidance, including those from the IMAGE project, recommend that a two-stepped approach - whereby the identification of a high-risk status through risk score technology - is confirmed by blood test.29 This type of stepped approach
has been shown to be the most cost-effective method of identifying risk status.\textsuperscript{30} A recent study estimated that using a one-step screening strategy where everyone receives an HbA1c, costs around €1,084 per case of T2DM detected. This is reduced to around €658 per case, if a two-stage strategy, employing a risk score, is used.\textsuperscript{31} Risk scores avoid the need for universal screening and the subsequent blood tests, ensuring that metabolically healthy individuals are not subject to intervention, and that those with undiagnosed T2DM are picked up earlier.

**LIFESTYLE INTERVENTIONS FOR THOSE AT RISK OF T2DM**

Observational research has consistently shown that 80-90% of all cases of T2DM result from an unhealthy lifestyle.\textsuperscript{32,33} Over the past two decades there have been several landmark diabetes prevention randomised controlled trials (RCTs) that have been conducted across diverse countries and populations,\textsuperscript{34-38} which have consistently shown that lifestyle intervention can reduce the risk of progression to T2DM by 30-60% in those with IGT. The Finnish Diabetes Prevention Study (DPS)\textsuperscript{34} and the American Diabetes Prevention Program (DPP)\textsuperscript{35} found that the risk of T2DM was reduced by 58% in people with IGT or IFG, given lifestyle counselling over a 3-year period. Similar findings were also seen in India,\textsuperscript{37} Japan,\textsuperscript{36} and China.\textsuperscript{38} Table 2 summarises the design and main findings from the major lifestyle intervention trials.

Lifestyle intervention in the prevention of T2DM has typically been focused on achieving a weight reduction, usually prescribed as a percentage of initial body weight (e.g. at least 5%) until a desirable BMI was achieved, increasing moderate intensity aerobic physical activity to at least $\geq 150$ minutes per week (one study also offered supervised resistance training), and diet modifications such as a reduction in total calories, total and saturated fat and sugar intake, and an increase in fibre, vegetables, and wholegrain products. These recommendations were delivered during one-to-one counselling sessions, and behaviour modification techniques such as motivational interviewing, self-monitoring, and individualised short and long-term goals were employed.

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**Table 1: Risk scores developed for use in Europe.**

<table>
<thead>
<tr>
<th>Score</th>
<th>Country</th>
<th>Outcome</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter99\textsuperscript{73}</td>
<td>Denmark</td>
<td>Undiagnosed T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>DESIR\textsuperscript{74}</td>
<td>France</td>
<td>Incident T2DM</td>
<td>Primary care*</td>
</tr>
<tr>
<td>PROCAM\textsuperscript{75}</td>
<td>Germany</td>
<td>Incident T2DM in males only</td>
<td>Primary care</td>
</tr>
<tr>
<td>German diabetes risk score\textsuperscript{76}</td>
<td>Germany</td>
<td>Incident and undiagnosed T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>FINDRISC\textsuperscript{33}</td>
<td>Finland</td>
<td>Incident T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>Hoorn\textsuperscript{77}</td>
<td>Netherlands</td>
<td>Undiagnosed T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>Rotterdam scores\textsuperscript{78}</td>
<td>Netherlands</td>
<td>Undiagnosed T2DM</td>
<td>(1) Primary care; (2) Self-assessment</td>
</tr>
<tr>
<td>SUNSET study\textsuperscript{79}</td>
<td>Netherlands</td>
<td>Known and undiagnosed T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>PORMETS\textsuperscript{80}</td>
<td>Portugal</td>
<td>Undiagnosed IFG and T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>Canary islands\textsuperscript{81}</td>
<td>Spain</td>
<td>Known and undiagnosed T2DM</td>
<td>Primary care</td>
</tr>
<tr>
<td>PREDIMED\textsuperscript{82}</td>
<td>Spain</td>
<td>Incident T2DM</td>
<td>Self-assessment</td>
</tr>
<tr>
<td>Cambridge\textsuperscript{83}</td>
<td>UK</td>
<td>Known and undiagnosed T2DM</td>
<td>Primary care</td>
</tr>
<tr>
<td>QD Score\textsuperscript{84}</td>
<td>UK</td>
<td>Incident T2DM</td>
<td>Primary care</td>
</tr>
<tr>
<td>Leicester risk scores\textsuperscript{14,85}</td>
<td>UK</td>
<td>Undiagnosed IGR and T2DM</td>
<td>(1) Primary care; (2) Self-assessment</td>
</tr>
</tbody>
</table>

*Those marked primary care are for population screening on medical records or require the results from invasive tests.

T2DM: Type 2 diabetes mellitus; IGR: impaired glucose regulation; IFG: impaired fasting glucose.
Overall, tested lifestyle interventions based on these targets have been shown to be equally or more effective than most pharmaceutical interventions in the prevention of T2DM. Importantly, successful lifestyle interventions have also been shown to have lasting benefits, even after the active intervention ceases. For example, in the DPS study, the intervention effect was sustained at 7 years and in the DPP, a relative reduction of 34% in diabetes incidence was maintained 10 years.

Table 2: Characteristics of the primary lifestyle interventions that have been tested in the prevention of Type 2 diabetes.

<table>
<thead>
<tr>
<th>Country</th>
<th>Study name</th>
<th>Sample size (men/women)</th>
<th>Inclusion criteria</th>
<th>Interventions</th>
<th>Lifestyle intervention targets</th>
<th>Study duration (weeks)</th>
<th>Risk reduction at end of intervention period*</th>
</tr>
</thead>
</table>
| China       | The Da Qing IGT and Diabetes Study38           | 530 (283/247)           | IGT, Age ≥25 years                                      | 1. Control 2. Diet 3. Exercise 4. Diet and Exercise | Diet group: Weight maintenance for normal weight. Weight reduction for those with a BMI ≥25 kg/m² through reduced energy intake  
Exercise group: Participants were encouraged to increase their physical activity by at least one prescribed unit per day (such as slow walking for 30 minutes, or fast walking for 20 minutes) and by two units per day where possible  
Diet-plus-exercise group: Combination of above | 6                                                                 | Diet: 31  
Exercise: 46  
Diet: 42 |
| USA         | Diabetes Prevention Research Group35           | 3,234 (1,043/2,191)     | IGT, Age ≥25 years, BMI ≥24 kg/m² (≥22 kg/m² if Asian), fasting plasma glucose ≥5.3 mmol/l | 1. Control 2. Lifestyle 3. Metformin                  | 150 minutes per week of MVPA and weight reduction (7% of initial body mass) through a healthy, high fibre, low-energy, fat controlled diet | 2.8                   | 58 |
| Finland     | Finish Diabetes Prevention Study24             | 522 (172/350)           | IGT, age 40 to 64 years old, BMI ≥25                   | 1. Control 2. Lifestyle                              | 30 minutes per day of MVPA and weight reduction (5% of initial body mass) through a healthy diet based on reduced saturated fat (10% of energy intake), reduced fat (30% of total energy intake), and high fibre | 3                      | 58 |
| India       | Indian Diabetes Prevention Programme37         | 531 (420/111)           | IGT                                                     | 1. Control 2. Lifestyle 3. Metformin 4. Lifestyle plus Metformin | 30 minutes per day of MVPA and healthy diet based on reduced energy intake with fibre rich foods low in refined carbohydrates and fats | 3                      | Lifestyle: 29  
Lifestyle and Metformin: 28 |
| Japan36     |                                                | 458/0                   | IGT                                                     | 1. Control 2. Lifestyle                              | 30 minutes per day of MVPA and weight reduction through a healthy diet | 4                      | 67 |

*% reduction compared to controls.  
IGT: impaired glucose tolerance; BMI: body mass index; MVPA: moderate-to-vigorous physical activity.
after randomisation (7 years after the intervention ended). Furthermore, the China Da Qing Diabetes Prevention trial showed that a relative risk reduction of 43% was maintained at 20 years (14 years after the intervention ended).

Although highly successful and shown to be potentially cost-effective in the longer term for ‘high risk’ individuals, these landmark intervention studies used intensive behaviour change strategies relying on multiple and lengthy one-to-one patient contacts which would be incompatible and unsustainable in a routine healthcare setting. For example, the DPS had a median of 20 one-to-one counselling sessions over a 4-year period. Several countries including the UK, US, Finland, Germany, and Australia responded to this limitation by developing, evaluating, and implementing diabetes prevention programmes that have been tailored to the needs of their specific healthcare settings. Although these pragmatic programmes have varied in context and scope, they have tended to centre on utilising group-based health educational programmes as the primary vehicle for promoting behaviour change. Evidence suggests that group-based programmes can be delivered successfully by a range of staff including nurses, dieticians, exercise specialists, and lay people.

In the UK it has been shown that a 3-hour group-based, theory-driven, structured education programme - combined with personalised pedometer use - can be highly successfully when delivered in a healthcare setting, with significant changes to health behaviour and improved metabolic health over a 12 and 24 month period in those with a high risk of T2DM. This brief group-based programme was refined into the Walking Away from T2DM programme, which includes a fully operational commissioning pathway for healthcare providers, including a standardised and accredited educator training and quality assurance programme. In Finland, population approaches to diabetes and cardiovascular disease prevention, that incorporate all elements of the healthcare profession, local government, and community partners, including offering individuals group-based lifestyle educational programmes, have been found to be effective. Similar approaches have also been introduced within other regions of Europe, including in Germany and countries involved in DEPLAN (diabetes in Europe-prevention using lifestyle, physical activity and nutritional intervention). Beyond Europe, the Centres for Disease Control in the United States have led the way in developing and evaluating components of a multi-faceted stepped approach to prevention that includes working with health insurance companies and referring high-risk individuals to community-led group-based diabetes prevention programmes run through YMCA facilities.

Evidence from several recent systematic reviews on the effectiveness of translational diabetes prevention programmes, suggests that a mean waist measurement reduction of around 4.5 cm and a mean weight reduction of around 2 kg is achievable over 12 months. This is lower than the amounts achieved by the intervention arms, the Finnish DPS (~4.2 kg) and the US DPP (~6.7 kg), at the same time point. However, a 2 kg weight loss is still clinically meaningful, with findings from the US DPP study suggesting that future diabetes incidence may be reduced by as much as 16% for each kilogram of weight lost. Whilst these results are encouraging, more research is needed to assess the longer-term (>12 months) effectiveness and cost-effectiveness of diabetes prevention programmes that have been implemented into routine care.

**Guidelines for Diabetes Prevention**

Recent evidence-based guidelines for diabetes prevention, compiled by NICE and the IMAGE project (Development and Implementation of a European Guideline and Training Standards for Diabetes prevention), make clearly defined recommendations for the essential components to include in any lifestyle programmes in order to maximise their effectiveness. Table 3 summarises the recommendations for design and content of lifestyle change programmes for preventing T2DM. These recommendations were informed by robust reviews of the relevant literature, and supplemented by expert opinion. It has recently been demonstrated that adherence to guideline recommendations on intervention content and delivery are associated with greater weight loss in a dose-dependent manner, with greater adherence leading to greater effect.

**The Future of Diabetes Prevention Lifestyle Research**

Recently, there has been increasing political recognition that diabetes prevention should be a major worldwide priority. For example, in 2011, the United Nations adopted a political declaration on
the prevention and control of non-communicable diseases (NCDs) that acknowledged the global burden and threat of NCDs including diabetes, and recognised that prevention must be the cornerstone of the global response to NCDs (http://www.un.org/ga/search/view_doc.asp?symbol=A/66/L.1).

**Table 3: Recommendations for design and content of lifestyle-change programmes for preventing T2DM.**

<table>
<thead>
<tr>
<th>Essential components of lifestyle programmes</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td></td>
</tr>
<tr>
<td>Establish motivation for behaviour change</td>
<td>Exploration of perceptions of risk for developing T2DM, exploration and reinforcement of reasons for wanting to change, confidence about making changes and expectations</td>
</tr>
<tr>
<td>Information provision</td>
<td>Raise awareness of the benefits of lifestyle changes (and changes needed)</td>
</tr>
</tbody>
</table>
| Lifestyle changes - aim to promote changes in both diet and physical activity | • ≥150 minutes/week of MVPA  
• Weight loss to reach and maintain a ‘healthy’ BMI  
• Consume wholegrain food products, at least five portions of fruit and vegetables, limit sugar and salt intake, increase consumption of dietary fibre, consume fish regularly, alcohol in moderation, reduce total amount of fat, and eat less saturated fat |
| Behaviour change and self-regulatory techniques - utilise established, well defined techniques | • Self-monitoring of physical activity and eating (e.g. with use of diet or pedometer)  
• Action plan of short and long-term goals (SMART goals)  
• Providing feedback on performance  
• Problem solving  
• Reflection  
• Relapse prevention  
• Overcoming barriers  
• Motivational interviewing  
• Prompting self-talk  
• Prompting practice  
• Individual tailoring  
• Time management |
| Social support                              | Facilitate/encourage social support (family, friends, and colleagues) for the planned behaviour change |
| Design                                      |         |
| Contact time                                | • Maximise the frequency or number of contacts (within the resources available)  
• Provide at least 16 hours of contact time over the first 9-18 months |
| Group versus individual                     | To balance cost and effectiveness - use group-based interventions with around 10-15 people where feasible |
| Person-centred approach                     | • Ensure programmes adopt an empathy-building approach. Supports person to become the expert and puts them in control |
| Time between sessions                       | • Ensure sessions are spread over a period of time - to allow people to make gradual changes to their lifestyle and reflect and learn from experiences  
• Allow time during group sessions for people to share this learning with others |
| Training and quality assurance              | • Ensure lifestyle programmes have a systematic and accredited method of training educators and regularly assessing compliance and competency; this is crucial for the professional development of health care professionals and standardisation of delivery when implemented over multiple sites |

T2DM: Type 2 diabetes mellitus; MVPA: moderate-to-vigorous physical activity; BMI: body mass index.  
*Summarised from IMAGE and NICE guidance.*
Research targeted to the prevention of T2DM must continue to be expanded to find the most effective methods of T2DM prevention in various settings. It is promising that major funding bodies have responded to this need. For example, the EU in general, especially through the Horizon 20/20 study, has put the prevention of chronic diseases at the heart of their agenda, with a range of calls from societal interventions to healthcare reorganisation and technological innovation. Ongoing EU funded work is also set to significantly advance knowledge. The PREVIEW study will include a multicentre RCT comparing two diet and two exercise strategies for 2,500 individuals with IGT and other risk factors. This study targets participants across the age spectrum, from children to the elderly. This is timely since the sharp rise in the levels of obesity and sedentary lifestyles witnessed in younger age groups has resulted in up to a 10-fold increase in the prevalence of T2DM in younger adults and youth. If left unconsidered, T2DM in the young will become one of the primary clinical priorities within the next couple of decades. This need also prompted the European Commission to set up tenders for pilot projects aimed at the development and implementation of successful prevention strategies for T2DM among children. Furthermore, diabetes prevention studies focusing on children are also ongoing in the US.

Individual countries have also recognised the need for effective diabetes prevention strategies and have funded research and policy change accordingly. For example, in England the National Institute for Health Research has committed substantial resources to funding research aimed at the prevention of T2DM and related chronic conditions across the translational spectrum, from experimental studies to implementation within primary care. However, at a national level, policy and research innovation tends to be very country-specific, reflecting the cultural and healthcare norms of the country in question. In order for diabetes prevention to be truly effective, it is likely that shared learning across countries will need to be actively promoted and supported. For example, the high-risk strategies currently promoted in the UK will only be effective if they are also combined with the societal, population-wide approaches that have been effective in Finland. Grassroots learning platforms have been set up to help disseminate international best practice, such as the network of diabetes prevention; such initiatives should be commended and actively supported.

It is also clear that along with these broader issues, diabetes prevention will also be influenced by other areas of importance, such as technology and targeted health behaviours. In recent years, it has been acknowledged that modern technology is likely to be of fundamental importance in providing a pragmatic and cost-effective avenue for self-management and behaviour change in the prevention and management of highly prevalent chronic diseases; the most ubiquitous of such approaches are based on mobile or smart phones. A recently published systematic review revealed that text messaging or smartphone applications are well accepted by participants, and may provide beneficial effects on reducing weight, decreasing waist circumference, decreasing BMI, decreasing fat mass, increasing physical activity, decreasing sugar-sweetened beverage intake, decreasing screen time, and encouraging healthier eating patterns. Furthermore, mobile phones have been used successfully in the prevention and management of T2DM. Results from recently published meta-analyses provide strong evidence that mobile phone interventions led to statistically significant improvements in glycaemic control and self-management in patients with T2DM. Researchers in India also demonstrated that in comparison to standard care, a mobile phone text messaging intervention reduced the incidence of T2DM in a high-risk population. Similar studies are also ongoing in Canada and the UK.

Lifestyle interventions used in the prevention of T2DM are also likely to receive innovation through the targeting of new behaviours. Over the past decade, sedentary behaviour (defined as non-exercise sitting) has emerged as an independent risk factor for chronic disease, including for T2DM. Indeed, recent studies in high-risk populations have shown that sedentary time actually has stronger associations with various markers of cardiometabolic health when compared with moderate-to-vigorous physical activity (MVPA). Furthermore, emerging experimental research demonstrates that reducing sitting time by regularly (e.g. every 20 or 30 minutes) performing short bouts (e.g. 2 minutes) of light ambulation throughout the day, significantly decreases postprandial glycaemia and insulinaemia compared to prolonged sitting. These studies
suggest that focusing on sedentary time and total movement throughout the day may be a more effective behavioural approach than solely promoting increased MVPA. The emerging evidence around sedentary behaviour has been picked up by several high profile international groups who are investigating the effectiveness of integrating interventions aimed at reducing daily sitting time into prevention initiatives. If successful, it is likely that diabetes prevention programmes in the future will include a strong focus on reducing daily sitting time in addition to the traditional behavioural targets.

**CONCLUSION**

In conclusion, those at high risk of T2DM can be readily identified as part of routine care, and the development of T2DM in such populations can be slowed or prevented through lifestyle intervention. However, further work is needed to effectively translate and embed this knowledge into routine clinical care throughout Europe and worldwide. Healthcare policy and law, research, technological innovation, and shared international learning are all central to ensuring the epidemic of T2DM is effectively addressed for future generations.

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