Following in the Footsteps of the North Karelia Project

Prevention of Type 2 Diabetes

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ABSTRACT

The prevalence as well as actual number of people with type 2 diabetes has been increasing in Finland during the past decades, in parallel with an increase in overweight and obesity. Besides obesity, population aging is among the main drivers of increasing numbers of diabetic patients. Type 2 diabetes brings along complications, most importantly cardiovascular diseases, and increasing type 2 diabetes prevalence has also been suggested to lead to a new upward turn in cardiovascular diseases. Therefore, it is important to implement activities to prevent type 2 diabetes. We present the trial evidence for the prevention of type 2 diabetes with emphasis on the Finnish Diabetes Prevention Study findings. Furthermore, we discuss the practical implementation of screening of individuals for high type 2 diabetes risk and prevention of type 2 diabetes in Finland at the population level and describe how they have contributed to European level initiatives.

Diabetes is acknowledged by the World Health Organization to be among the 4 major noncommunicable diseases along with cardiovascular diseases (CVD), cancers, and respiratory diseases [1]. In 2008, over half a million Finnish people (around 11% to15% of Finnish women and men aged 40 to 70 years) were estimated to have diabetes. Half of them were not yet aware that they had the disease [2].

The most important lifestyle-related risk factors for type 2 diabetes (T2D) are obesity, a sedentary lifestyle, and unhealthy diet [3]. Beneficial changes in dietary composition, especially the markedly reduced intake of total and saturated fat and an increased consumption of vegetables have occurred in Finland during the past decades. These dietary changes have led to the marked reduction in CVD mortality and morbidity in Finland. This beneficial trend in consumption of saturated fats seems to have come to an end and turned for the worse again during the recent years. Leisure time physical activity has increased; however, physical activity at work and walking or bicycling to work have decreased gradually, which indicates that total physical activity may not have increased [4].

Obesity and overweight have increased in Finland during the last few decades. However, the long increasing trend in the prevalence of obesity seems to be levelling off [5]. There is some evidence that the T2D prevalence trend is following the obesity pattern (Fig. 1A). The steep increase in incidence of drug-treated T2D observed in Finland between the years 2006 and 2011 could reflect the concurrent diabetes screening and prevention activities established in Finland—it is known that when screening is increased, more previously unknown cases are identified (Fig. 1B). After the peak in 2011, the incidence has declined significantly. The prevalence and incidence estimates of T2D are, however, inaccurate in the sense that there is no reliable way to collect cumulative T2D morbidity data in Finland. The changing diagnostic criteria, increased awareness leading to more screening activities, and new treatment guidelines and availability of new drugs may also have had an effect on both incidence and prevalence.

PREVENTION OF TYPE 2 DIABETES: CLINICAL EVIDENCE

The first controlled, individually randomized trial to test the possibility of T2D prevention by lifestyle intervention was the Finnish Diabetes Prevention Study (DPS) [6]. The DPS was a multicenter study that started in 1993, was coordinated by the National Public Health Institute, and completed in 5 centers in different areas in Finland. Altogether, 522 middle-aged, overweight men and women with high T2D risk (defined as IGT detected during 2 consecutive 75-g oral glucose tolerance tests) were recruited and randomly allocated into a "standard care" control group or intensive lifestyle intervention group [7,8].

The lifestyle intervention was delivered primarily by study nutritionists during individual counselling sessions and highlighted by study physicians at annual clinical visits [8]. The intervention goals were to reduce body weight (5% or more reduction from baseline weight), limit dietary fat (<30% of total energy consumed) and saturated fat (<10% of total energy consumed), and to increase both dietary fiber intake (15 g/1,000 kcal or more) and physical

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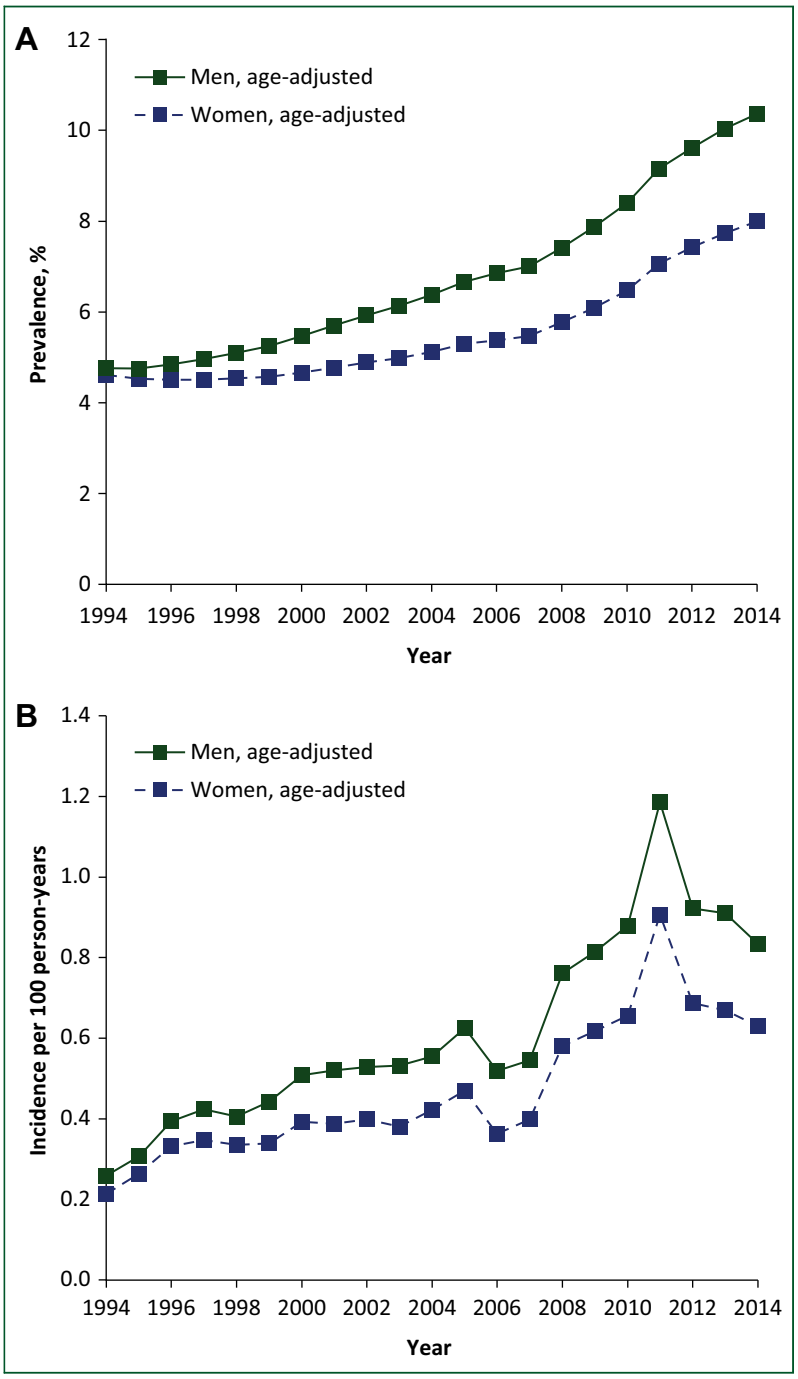

FIGURE 1. Prevalence (A) and incidence (B) trends of special reimbursements for diabetes medicines granted by the Social Insurance Institution of Finland from 1994 to 2014 among men and women aged 35 and older.

activity (≥30 min/day). T2D status was assessed annually by a repeated 75-g oral glucose tolerance testing.

The intervention group showed significantly greater improvement in each intervention goal compared with the control group. After 1 and 3 years, mean weight reductions were 4.5 and 3.5 kg in the intervention group, and 1.0 kg and 0.9 kg in the control group. Cardiovascular risk factors improved more in the intervention group [8,9]. After a mean follow-up of 3.2 years, the risk of T2D was reduced by 58% in the intervention group compared with the control group [6]. The reduction in the incidence of T2D was directly associated with the number of achieved lifestyle goals. Increasing physical activity was shown to be an independent predictor of T2D risk reduction [10]. Furthermore, those who consumed a moderate-fat, high-fiber diet achieved the largest weight reduction and, even after adjustment for weight reduction, had the lowest T2D risk during the intervention period [11]. After discontinuation of the counselling, the differences in lifestyle variables between the groups still remained favorable for the intervention group. During the total follow-up period until 13 years, the risk of T2D was still 39% lower among the former intervention group participants, compared with the former control group participants [12]. The effect was statistically significant within both men and women (Fig. 2).

After the DPS, several clinical trials, most importantly the U.S. Diabetes Prevention Program, have confirmed the finding. In 2002, it reported exactly the same risk reduction of 58% [13]. It has also been reported that lifestyle intervention is both more effective and cost-efficient than prevention using glucose-lowering medication [14].

SCREENING FOR HIGH T2D RISK

A practical problem in "real-world" T2D prevention is how to identify individuals with increased T2D risk and discern who would benefit from intensified actions to prevent development of T2D. There are several tools available to identify people at increased risk of incident type T2D [15]. One of the commonly used tools is the FINDRISC (Finnish Diabetes Risk Score) [16]. It was developed using the longitudinal follow-up data of the FINRISK survey 1987 and 1992 population-based cohorts with new cases of drug-treated T2D as the endpoint, ascertained using the Social Insurance Institution's Drug register. With 8 simple questions (age, body mass index, waist circumference, family history of diabetes, antihypertensive medication use, consumption of fruit and vegetables, physical activity, history of high blood glucose), a relatively good estimate of 10-year T2D risk can be achieved. The FINDRISC has been validated for use, as such or after adaptations, in several countries [17-23].

The FINDRISC is unique in that it focuses on predicting future T2D with several factors that are fast and easy to measure with noninvasive methods, known to be associated with the risk of type T2D. It is easily comprehensible and directs a person's attention to the modifiable risk factors of T2D. Interpretation of the individual's T2D risk is easy and can be expressed as a probability in a relatively accurate way. Using the FINDRISC can

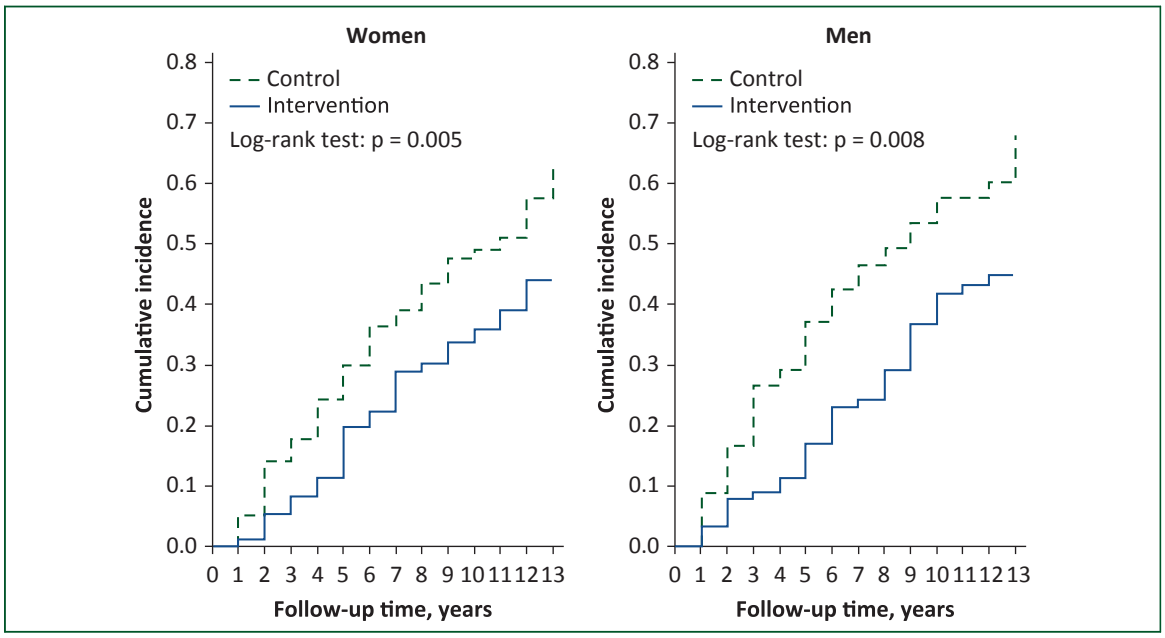

FIGURE 2. Cumulative incidence of diabetes in the intervention and control groups of the Finnish Diabetes Prevention Study (DPS) by sex.

drastically reduce the number of invasive tests required at the screening phase.

Even though the FINDRISC was designed to predict future T2D risk, it has proven to be a reasonably reliable method also in identifying previously unrecognized T2D in a random population sample [24]. In addition, the risk score is a reasonably good predictor of coronary heart disease, stroke, and total mortality [25]. This provides additional support that lifestyle interventions for subjects with high FINDRISC are warranted.

PRACTICAL IMPLEMENTATION OF T2D PREVENTION

Implementation project for the prevention of T2D in Finland—the FIN-D2D

A crucial question is whether the results obtained in the efficacy trials can be replicated in routine health care, which has much more limited resources available for delivery. As part of the DEHKO (National Development Programme for the Prevention and Care of Diabetes), an implementation project, FIN-D2D (Program for the Prevention of Type 2 Diabetes in Finland), was carried out in 5 of the 21 hospital districts in Finland during the period 2003 to 2007 [26]. The implementation project proved that large-scale screening was feasible: >20,000 moderate-risk and high-risk individuals were identified, and interventions based on the same principles as in the DPS were offered to them.

The main objective of the implementation project was to organize and develop prevention models that would be feasible within the primary and occupational health care system. The principal screening tool to identify individuals with high T2D risk was the FINDRISC [16]. High-risk individuals underwent an oral glucose tolerance test and were referred to lifestyle interventions, delivered mostly by public health nurses in collaboration with local multiprofessional teams if available. In Finland, routine preventive health services including risk factor control measures and health education are typically delivered by public health nurses. The nurses were trained to motivate and instruct the participants to make beneficial changes in their lifestyles. Weight management, dietary counselling, and physical activity were the basis for prevention. As the resources in the primary health care are scarce, the advised strategy was group intervention, but individual and self-acting interventions could also be used.

After 1-year follow-up, there were desirable changes in CVD risk factors and glucose tolerance in the high-risk cohort in both sexes [27]. The risk reduction of T2D was 69% in those individuals who were able to lose at least 5% of their weight. Successful weight loss was associated with the number of intervention contacts between the client and caregiver [28]. Most importantly, the project showed that implementing effective large-scale lifestyle interventions in primary health care is possible. However, certain problems and challenges were encountered, especially in relation to the limited resources allotted to preventive health care. The other major obstacle for the more successful result was that only around one-third of high-risk individuals were willing to take part in the prevention activities offered to them free of charge.

Another principal aim of the DEHKO was to increase the awareness of T2D in Finland. The Finnish Diabetes Association was active in different areas of society to increase the knowledge of T2D, and glucose measurements were performed in several large-scale public events. The program was also promoted on TV and radio, in magazines and newspapers, and at local activities. Due to these activities, the population-level knowledge about risk factors of T2D and prevention possibilities increased in the project areas, and especially men reported having made beneficial changes in their lifestyle [29].

Collaboration between different stakeholders in Finland

The first prevention efforts aiming to reduce the risk of CVD in Finland started already in late 1950s and early 1960s. From the very beginning, nongovernmental organizations such as the Finnish Heart Association were active in the prevention of chronic diseases. The Finnish Diabetes Association was the initiator and the key stakeholder in DEHKO and D2D.

However, none of the national programs would have been possible without financial and other support from the Finnish government and good collaboration among different partners. National Public Health Institute (nowadays the National Institute for Health and Welfare) has also been one of the key players at the national level. Nevertheless, the importance of grassroots-level work, which has been done by voluntary people of patient/public health care associations, and the commitment of primary health care need to be recognized. Important issues for the success of prevention of chronic diseases further include careful planning, commitment, training, and collaboration. A national health monitoring system is mandatory to evaluate the effectiveness of any program. Any real effort also requires money to create it. In this regard, the Finnish government has offered earmarked money for different national efforts [30,31].

European initiatives for improved T2D prevention

The DE-PLAN (Diabetes in Europe—Prevention Using Lifestyle, Physical Activity and Nutritional Intervention) project [32], led by the University of Helsinki was the first European-wide effort aimed to tackle the T2D problem, building on the Finnish experience in T2D prevention. The DE-PLAN project aimed at developing and testing models of efficient identification and intervention of individuals at high risk of T2D in the community. Altogether, 17 countries developed programs and trials, some of which are currently used as a basis of formation of national diabetes plans and some opening important new paths in T2D prevention [33-35].

An important step forward in T2D prevention was the formation of European multidisciplinary consortium IMAGE (Development and Implementation of a European Guideline and Training Standards for Diabetes Prevention) that brought together the state-of-the-art knowledge on T2D prevention in Europe. It produced evidence-based guidelines for diabetes prevention [3] and the Toolkit for diabetes prevention [36], as well as "Quality and Outcome Indicators for Type 2 Diabetes Prevention" [37].

FUTURE DIRECTIONS

The effects of lifestyle intervention to prevent T2D in high-risk individuals have been firmly demonstrated in clinical trials. As presented in a recent systematic review and meta-analysis by Dunkley et al. [38], prevention of T2D can be effective also in the real world. Furthermore, they showed that adherence to the IMAGE guideline recommendations is associated with the effectiveness of the T2D prevention interventions. The extension of the DPS study demonstrated that lifestyle intervention lasting for a limited duration can lead to sustained lifestyle modification and prevention of the development of T2D also in the long term [12]. These experiences indicate that there is great potential in using lifestyle intervention to reduce the burden of T2D among high-risk individuals.

The implanting of effective prevention activities into primary health care in a feasible and cost-effective way is still under debate [39]. The ongoing JA-CHRODIS 2014–2016 (Joint Action on Chronic Diseases and Promoting Healthy Ageing Across the Life Cycle) is a European Union–cofunded initiative aiming to promote and facilitate the exchange and transfer of good practices on chronic diseases between European countries and regions [40]. An important outcome of the initiative will be commonly agreed quality criteria for health promotion and chronic disease prevention and care. Specifically, JA-CHRODIS has chosen T2D as a "case study" [41]. The ultimate aim is to launch a platform for knowledge exchange to enable all stakeholders throughout Europe to have access to best practices in chronic disease prevention and care.

It is obvious that the T2D epidemic cannot be solved by concentrating on high-risk strategies and preventive actions carried out by the health care system. T2D is a societal problem and therefore there is a need to develop and implement primary prevention programs targeting the population as a whole. In particular, the importance of cooperation and a multisectorial approach should be emphasized. A large number of stakeholders and sectors should be involved at all levels of society. Citizens' awareness of the importance of a healthy lifestyle has to be increased, and there is a need to address social inequalities in diet, physical activity, and obesity. Healthy lifestyle choices have to be made accessible and affordable; at the same time, the less healthy choices could be made less appealing, for example, by taxation (e.g., sugar tax). We have to influence and work together with the educational system, food industry, media, urban planning, and nongovernmental organizations. We need to support local communities and workplaces in their efforts to promote healthier lifestyles.

Furthermore, we need to explore new ways to affect peoples' lifestyle choices. As an example, the National Institute for Health and Welfare has recently developed and launched a website [42] where citizens can, for example, test their risk of getting T2D, CVD, or cognitive disorders in the future. The aim of the test is to guide people to contemplate about their future risks, to lead them to reliable information sources, and, if needed, to direct them to seek advice from health care professionals.

The International Diabetes Federation does not support untargeted screening to identify individuals at risk to get T2D in the future [43]. However, when knowledge about T2D increases and more people are tested for T2D that inevitably leads also to identification of individuals at high T2D risk. We know that the development of T2D via various stages of insulin resistance and hyperglycemia into overt disease can take 10 years or longer. This "lag period" is an important window of opportunity for preventive actions. It offers the time to prevent or delay the development of T2D among these individuals at risk by lifestyle modifications. The results of DPS suggest that among high-risk participants, lifestyle intervention will give, on average, 5 diabetes-free years. Failing to provide the intervention that we know to be effective would be unethical.

SUMMARY

Activities related to the prevention of T2D in Finland follow a similar pattern as prevention of CVD a few decades earlier. Emerging health challenges such as obesity and T2D in the population can be identified using a national health monitoring system. With epidemiological research, modifiable risk factors and determinants for these have been identified and the potential for prevention can be evaluated. With randomized intervention trials, efficacy of interventions can be studied and demonstrated. Based on the past experiences on prevention of cardiovascular disease and T2D, the potential of prevention of memory disorders with lifestyle factors is currently under evaluation in a randomized setting in Finland [44]. Based on these experiences, tools supporting primary prevention, such as risk scores to identify people at high risk, can be developed. Finally, implementation of both population and high-risk strategies for prevention has been done in order to increase awareness of the disease and its risk factors and to identify those at high risk and provide targeted interventions to them. It is important to recognize that the time frame for this process with regard to chronic diseases is usually long; the implementation phase alone will take several years, and even longer time is required to evaluate the effectiveness of these activities.

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