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Are Lifestyle Intervention Strategies Successful to Prevent Type Diabetes 2? What are the Mechanisms of Action?

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INTRODUCTION

Prediabetes is classified as a clinical state intermediate between normal glucose metabolism and diabetes, identifying subjects at high risk for developing diabetes in the future. It is defined by fasting glucose levels between 110 and 125 mg/dL (IFG) or 2-h postprandial glucose levels after 75-g Oral Glucose Tolerance Test (OGTT) between 149 and 199 mg/dl (IGT) or Hemoglobin A1c (HbA1c) levels between 5.6 and 6.4% [1,2]. According to a large, population-based cohort study in Dutch population of 2540 participants, the risk for developing diabetes type 2 over 6 years is 9.1% for IFG, 32.5% for IGT and 64.5% for combined IFG/IGT [3]. Concerning HbA1c, a systematic review of 44203 individuals from 16 cohort studies suggested that those with HbA1c between 5.5 and 6% have a 9 to 25% risk for developing diabetes over 5 years, while HbA1c range of 6.0-6.5% have a 25-50% risk of developing diabetes [4]. It is suggested that lifestyle intervention, including weight loss and physical activity improvement, could reduce the risk of diabetes type 2 in individuals with prediabetes. Many studies have investigated the effect of mid- and long- term lifestyle changes in the prevalence of diabetes.

One of the largest randomized controlled trials which investigated the effect of lifestyle intervention in prevention of diabetes was the Diabetes Prevention Program (DPP). It is a 27-center around the United Stated randomized clinical trial which investigated the effect of lifestyle intervention or metformin on the diabetes incidence in subjects with IGT. The study enrolled 3234 participants and they were randomly divided into 3 different groups. The intervention group aimed to reduce their weight at least 7% and increase their physical activity level at the minimum goal of 150 min of moderate intensity/week. The second group took 1700 mg of metformin divided into 2 doses/day and the third group was the control (Placebo). The duration of the study (DPP) was 2.8 years after randomization and the primary outcome was the development of diabetes measured once per year. The duration of the follow-up (DPPOS) was 10 years after randomization. The lifestyle intervention in the DPP was goal-based behavioral intervention and some of the key features included a 16-session, face-to-face program, ensuring that all participants were taught the same information about weight maintenance, physical activity and behavioral self-management. Specialized trainers were responsible to motivate the participants and deliver the core curriculum [5,6].

At the first 2.8 years the incidence of the disease during DPP was the highest in the placebo group (10.0%), 7.8% in the metformin group and the lowest in the lifestyle group (4.8%). The lifestyle group reduced the incidence of diabetes by 58% and metformin group by 31% compared with placebo. At the 10 years period the reduction of diabetes prevalence was the greatest in lifestyle group and equal to 34% and by 18% in metformin group compared with placebo. In this study, development of diabetes was delayed about 4 years by lifestyle changes and 2 years by metformin compared with placebo. The weight loss in the lifestyle intervention group was the greatest (A mean of 7 kg by 1 year) but it was gradually regained, while the difference between the baseline and at the end of the study was 2 kg. The metformin group lost a mean of 2.5 kg during DPP and maintained until the end of the study [6].

The China Da Qing Diabetes Prevention (CDQDPS) was a 33-multicenter randomized control trial in which 577 adults with IGT were randomly divided into 3 lifestyle intervention groups (Exercise, diet or both) or control group. The duration of the study was 6 years after randomization and the primary outcomes were the diabetes development, CVD and mortality once per 2 years. The duration of the follow-up was 20 years after randomization. The diet group was assigned to diet containing 25-30 kcal/kg of body weight, 55-65% carbohydrate, 30-35% fat and 10-15% protein. They were encouraged to eat more fruits, reduce their simple carbohydrates intake and control their alcohol. Overweight and obese participants were encouraged to lose weight of 0.5-1.0 kg/month. The exercise group was encouraged to increase

the amount of leisure physical activity by 1 unit per day, which was equal to 30 min of mild exercise, 20 min of moderate exercise, 10 min of strenuous exercise, or 5 min of very strenuous exercise. Frequent counseling sessions were included for all groups during the study [7].

At the first 6 years of the active intervention, the incidence of diabetes was reduced in the combined lifestyle group by 51% and specifically the prevalence of the disease was 43% in the lifestyle group and 66% in the placebo group. During the 20-years follow-up, the intervention group had 43% lower diabetes incidence compared to placebo and specifically the prevalence was 80% in the lifestyle group and 93% in the placebo group. [8].

The Finnish Diabetes Prevention Study was a randomized control multicenter with 5 center trial in Finland. The study participants were 522 middle-aged, overweight subjects with IGT and they were equally divided into intervention or placebo (Control) group. The duration of the active intervention period was 4 years, with a 3 years follow-up. The main goals of the intervention group was to achieve 5% or more weight loss, 30 min or more per day moderate physical activity, 30% of total energy intake or less dietary fat, 10% of total energy intake or less saturated fat and 15 g fiber or more per 1000kcal. Intervention group had face-to-face consultation session of a preplanned topic with nutritionists during the study. Three-day food records were taking place 4 times/year helping the nutritionists give appropriate dietary advice to participants. Participants were encouraged to measure and record their weight and their dietary intake at home frequently. Organized and individually circuit-type training sessions to improve the strength and capacity of participants were available without additional fees. The placebo group was informed only about lifestyle guidelines and disease risk factors [9].

During the first 4 years of intervention, the prevalence of the disease was 18% and 30% in the lifestyle and placebo group, respectively. At the end of the total follow up of 7 years the prevalence of the disease was 46% and 87% in the lifestyle and control group, respectively, showing a disease risk reduction equal to 42% [10].

The studies mentioned propose that lifestyle intervention in individuals with impaired glucose tolerance can have an impact on diabetes risk. The key determinants of lifestyle intervention include weight loss, physical activity and changes in dietary composition where each one can independently improve glucose metabolism via several mechanisms.

During chronic positive energy balance, insulin resistance increases and visceral fat as well as subcutaneous and total body fat increase resulting in decrease in insulin suppression of liver glucose production and increased plasma glucose. In addition to that, the increased liver fat increases secretion of triacylglycerol exposing pancreatic islets to fatty acids resulting in decreased insulin secretion. These mechanisms contribute to β-cells dysfunction and diabetes type 2. Weight loss and negative energy balance reduce liver fat improving glucose metabolism by increasing insulin suppression of liver glucose production, improving glucose-stimulated insulin secretion, decreasing plasma triacylglycerol and glucose [11]. Adipose tissue and large fat cells seem to produce an entirely different pattern of hormones and inflammatory factors, such as adiponectin and leptin, than small adipocytes. Insulin resistance can be explained by these alternations in the production of inflammatory factors affecting glucose metabolism. Thereby weight loss can reduce the size of fat cells, normalizing the profile of these factors and improving glucose metabolism and insulin resistance [12,13].

Physical activity seems to improve glucose tolerance, independent of reducing weight and increasing energy expenditure, via improved capacity to oxidize fatty acids. Fatty acid oxidation increases during exercise reducing the accumulation of lipids and lipotoxic intermediated in skeletal muscle and thereby improving insulin sensitivity [12]. Exercise increases insulin sensitivity and promote movement of glucose from blood to muscles, decreasing insulin plasma levels [14]. Physical activity promotes an insulin-independent mechanism that regulates glucose uptake which means that muscle contraction and exercise can activate signals and glucose transport in skeletal muscle which are not stimulated by insulin [15].

Many dietary factors are proposed to affect diabetes development. Dietary fibers delay absorption of carbohydrates in the intestine after a meal and thereby decrease the postprandial glycemic and insulinemic responses [16]. It is proposed that type and amount of dietary fat intake, not only favors increased energy intake and obesity, but also affect the phospholipid composition of cell membranes in skeletal muscle and other tissues, affecting insulin receptors and sensitivity [12]. Excess saturated fat seems to decrease skeletal muscle insulin sensitivity [17]. Dietary monounsaturated fat and polyunsaturated fat improve insulin sensitivity by increasing the fluidity of membranes facilitating membrane and insulin signaling and may influence the regulation of genes involved in the breakdown and oxidation of fatty acids [16,18].

In conclusion, although the study design and the goals of intervention group in the studies mentioned are not exactly the same, the studies mentioned illustrate that lifestyle intervention can have a beneficial impact on diabetes risk.

BIBLIOGRAPHY

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2017;33(Suppl. 1):S13.
2. Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 1997;20:1183-1197.
3. Vegt F, Dekker JM, Jager A, et al. Relation of impaired fasting and postload glucose with incident type 2 diabetes in a Dutch population: The Hoorn Study. JAMA. 2001;285:2109-2113.
4. Zhang X, Gregg EW, Williamson DF, et al. A1C level and future risk of diabetes: a systematic review. Diabetes Care. 2010;33:1665-1673.
5. The Diabetes Prevention Program (DPP) Research Group. The Diabetes Prevention Program (DPP): Description of lifestyle intervention. Diabetes care. 2002;25(12):2165-2171.
6. Diabetes Prevention Program Research Group, Knowler WC, Fowler SE, Hamman RF, Christophi CA, Hoffman HJ, Brenneman AT, Brown-Friday JO, Goldberg R, Venditti E, Nathan DM. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet. 2009;374(9702):1677-1686.
7. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. Diabetes Care. 1997;20(4):537-544.
8. Li G, Zhang P, Wang J, Gregg EW, Yang W, Gong Q, et al. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study. Lancet. 2008;371(9626):1783-1789.
9. Uusitupa M, Louheranta A, Lindström J, Valle T, Sundvall J, Eriksson J. The Finnish Diabetes Prevention Study. Br J Nutr. 2000;83:S137-S142.
10. Lindström J, Ilanne-Parikka P, Peltonen M, Aunola S, Eriksson JG, Hemiö K. Finnish Diabetes Prevention Study Group. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. Lancet. 2006;11;368(9548):1673-1679.
11. Taylor R. Pathogenesis of type 2 diabetes: tracing the reverse route from cure to cause. Diabetologia. 2008;51(10):1781-1789.
12. Roumen C, Blaak EE, Corpeleijn E. Lifestyle intervention for prevention of diabetes: determinants of success for future implementation. Nutr Rev. 2009;67(3):132-146.
13. Ravussin E, Smith SR. Increased fat intake, impaired fat oxidation, and failure of fat cell proliferation result in ectopic fat storage, insulin resistance, and type 2 diabetes mellitus. Ann N Y Acad Sci. 2002;967:363-378.

14. Camacho RC, Galassetti P, Davis SN, Wasserman DH. Glucoregulation during and after exercise in health and insulin-dependent diabetes. Exerc Sport Sci Rev. 2005;33(1):17-23.
15. Krook A, Wallberg-Henriksson H, Zierath JR. Sending the signal: molecular mechanisms regulating glucose uptake. Med Sci Sports Exerc. 2004;36(7):1212-1217.
16. Bazzano LA, Serdula M, Liu S. Prevention of type 2 diabetes by diet and lifestyle modification. J Am Coll Nutr. 2005;24(5):310-319.
17. Borkman M, Storlien LH, Pan DA, Jenkins AB, Chisholm DJ, Campbell LV. The relation between insulin sensitivity and the fatty-acid composition of skeletal-muscle phospholipids. N Engl J Med. 1993;328:238-244.
18. Riccardi G, Giacco R, Rivellese AA. Dietary fat, insulin sensitivity and the metabolic syndrome. Clin Nutr. 2004;23:447-456.