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Primary Prevention of Obesity and Type 2 Diabetes Mellitus

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Abstract

The prevalence of type 2 diabetes mellitus has exceeded 22million people in Europe and according to WHO, it will increase from 135 million in 1935 to 300 million in 2025. In 1989 Saint Vincent Declaration, elaborated by the International Diabetes Federation (IDF) called all the European countries to take action aimed at reducing the prevalence of type 2diabetes mellitus and its complications on the population level. Poland has signed the Declaration within the "Polish Multicenter Study in Diabetes Epidemiology (PMSD) program (implemented in the cities of Kraków, Łódź, and Lublin), financed by the Ministry of Health, and developed within the years of 1998–2000. The program was coordinated by the Chair and Department of Endocrinology, Jagiellonian University, Collegium Medicum in Kraków. It revealed over 2 million diabetics in Poland, half of which represented the so-called unknown diabetes, diagnosed for the first time in the course of investigation. The prevalence of type 2 diabetes mellitus is still growing up owing to the increasing prevalence of its main risk factors: overweight and obesity, mainly the visceral type. The basic method of preventing of the type 2 diabetes mellitus within the PMSD is body weight reduction with an increase in physical activity and an appropriate educational program. The second basic goal of the program in the highest risk group of type 2 diabetes mellitus is to decrease blood pressure in hypertensive patients.

Hypertension management is based on salt intake reduction, however, salt is the main carrier of iodine in the iodine prophylactic system in Poland so iodine must be additionally supplemented with additional carriers, such as milk or iodized mineral water: "Ustronianka" "Jodavit" or "Wysowianka". The results of the program point out that the process of type 2 diabetes mellitus formation is reversible, but under the condition of early intervention. Additional parts of the program are economic burden evaluation and resort management. The resort of "Wysowa S.A." has already been prepared to implement prevention and management in patients with overweight, obesity, and type 2 diabetes mellitus. On July 4-5, 2013, the International Ministerial Conference in Vienna took place. It was the first conference in the context of the "Global Plan of WHO Action in Prevention and Control of Non-communicable Diseases 2013-2020" (Health 2020) program, approved of by the 66th World Health Assembly and the 8th Global WHO Conference on Health Promotion in Helsinki. The conference also resulted in issuing the Vienna Declaration, which points at continuing the Ministerial Conference on Counteracting Obesity that took place in Istanbul in 2006. The documents raised the problems of healthy food and preventing food-related non-communicable diseases, as well as lead the way to renew the WHO "Action Plan for Food and Nutrition Policy" program, which expired in 2012.

Keywords: Etiology; Pathogenesis; Epidemiology; Obesity; Type 2 diabetes mellitus

Introduction

In 1989 International Diabetes Federation and WHO published so called "St. Vincent Declaration" signed by representatives of the European countries among them by Poland-indicating on the endemic growth of the type 2 diabetes mellitus and necessity in undertaking the proper measures to reduce the consequences of the disease [1]. World Health Assembly in 1992 elaborated and issued report on the national strategy for overcoming the main risk factor of type 2 diabetes mellitus obesity [2] and in 1999 WHO published basic definition and classification for diabetes [3]. European Regional Consultation of WHO in Copenhagen in 2003 defined global strategy on diet, and physical activity as a basis for primary prevention of the type 2 diabetes mellitus [4]. Obesity and type 2 diabetes mellitus are the main public health problem over the world and has been qualified by the World Health Organization as non-communicable disease [5,6]. Associated complications: hyperinsulinemia, dyslipidemia hypertension and cardiac complications are collectively termed "insulin resistance syndrome" and its prevalence is still growing up [7-9]. The pathogenesis of this complex metabolic disease is based on genetic susceptibility; however the leading risk factors evolve in behavior factors: uncontrolled high caloric diet and sedentary style of life. National burden of obesity and type 2 diabetes mellitus is still increasing, and create a serious economic and social problem over the world. Therefore, preventive measures based on non-pharmacological intervention provide a common platform recommended by WHO to stop spreading of these diseases [5]. We have focused to study on the primary prevention of obesity and type 2 diabetes mellitus in the lights of the high prevalence of these diseases in the Polish population.

The aim of this article is to indicate the real possibilities to prevent the obesity and type 2 diabetes mellitus from spreading.

Epidemiology

The Epidemiologic survey of the years 1985-1986 in Warszawa, Kraków, Wrocław "Three Cities Study" revealed high prevalence of the type 2 diabetes mellitus is in the people over 35 years old (10.77%,

15.6% and 15.7% respectively) [10,11]. In the period of time 1998-2000 Department of Endocrinology, Jagiellonian University, Collegium Medicum in Krakow was a main coordinating center for the Polish Multicenter Studies on Diabetes Epidemiology financed by the State Committee for Research, and Ministry of Health. This Program which leading centers for diabetes mellitus in Poland took part in, revealed high prevalence of the type 2 diabetes mellitus 5.37% over 2 million diabetic patients mainly over 30 years old with high contribution (50-70%) of the new diagnosed cases never before diagnosed and treated so called "unknown" diabetes [12]. As a continuation of this survey we implemented the pilot study on the model of identification the persons at risk and non-pharmacological intervention on the primary health care level in the local community in Krakow financed initially by the Ministry of Health and since 2003 by the Municipality of Krakow town within the framework of the preventive programme "Healthy Krakow". In 2004 Council of the Municipality of Krakow Town approved "Program for Primary Prevention of Type 2 Diabetes, Hypertension and Arteriosclerosis" for the years 2004-2006, which actually is continued. This endemic level has been confirmed few years later by the results of the investigation preformed in 2001 [13] and within the "WOBASZ" project: Polish Multicenter Study on Health Population [14] where prevalence of overweight and obesity in the group of age 20-74 was 61.6% in men and 50.3% in women [15] and prevalence of the metabolic syndrome in people over 60 years was 34.5% and 46.34% respectively [16]. These data are in accordance with results on low physical activity 35% of the adult population [17]. Similar alarming data have been supplied on overweight and obesity prevalence in children and adolescents from "Three cities study" [18] and in epidemiologic survey in Krakow region: 15.2% in boys and 11.8% in girls within the group of age 7-10 years [19] and in the group of age 7-9 years [20].

These data reflect an endemic situation of type 2 diabetes mellitus and leading risk factors: overweight and obesity in Polish population. In comparison to data obtained several years before, significant increase is observed.

Similar data are reported by H. King confirming epidemic situation in the USA and global epidemiologic situation of the type 2 diabetes mellitus and obesity [21]. According to his prediction the number of adults with diabetes mellitus will rise over the world from 135 million in 1995 to 300 million in 2025.

Etiology and Pathogenesis

The genetic background of the obesity and type 2 diabetes mellitus has been confirmed in many investigations and large proportions of the world population are carrying the gens that permit development of the diseases. Especially polymorphism of the Beta 2-adrenoreceptor gene [22,23] and glucokinase gen [24,25] is associated with obesity and type 2 diabetes mellitus development. This genetic impact has been confirmed in investigation among family members with obesity and type 2 diabetes mellitus [26-29].

However it is generally accepted that genetic compliance is not the leading risk factor and that sedentary style of life with non-controlled high caloric diet lead to obesity, type 2 diabetes mellitus and in consequences to arteriosclerosis (Table 1). This environmental factor creates a real possibility for non-pharmacologic intervention on the population level in the preventing systems. Additional risk factors of the type 2 diabetes are smoking [30] and alcohol consumption [31,32].

Reasons	Risk Factor
Genetic	Age, diabetes in family
Biologic	Pregnancy, menopause
Style of Life	Obesity, low physical activity

Table 1: Primary risk factors of type 2 diabetes mellitus.

The first step toward primary prevention of the type 2 diabetes mellitus is early identification of individuals with diabetes risk factors (Table1).

Apart from anthropometric data (Body Mass Index-BMI, Waist/Hip Ratio-WHR),the leading diagnostic test is two hours oral glucose (75 g) tolerance test, when fasting glucose level is much less effective (50% of sensitivity).

Among metabolic markers serum insulin level is the most important, as a main factor of insulin metabolic syndrome introduced by Raven in 1988, and in 1999 WHO included obesity, glucose intolerance or type 2 diabetes mellitus, albuminuria and creatinuria (Table 2) [3,33-36].

1	Obesity (BMI >30.0, WHR-women >0.85, men >0.9)
2	Hyperinsulinemia (fasting level >15,0 μ/ml)
3	Glucose intolerance (fasting level 5,0-6,9 mmol/l) or type 2 diabetes mellitus (fasting level >7.0 mmol/l)
4	Arterial hypertension (>140/90 mmHg)
5	Microalbuminuria (>20 μg/l, or albuminuria)
6	Creatinuria (>30 mg/g)
7	Dyslipidemia (TG >1.7 mmol/l, cholesterol HDL (women >1.0 mmol/l, men >0.9 mmol/l)

Table 2: The components of the insulin metabolic syndrom [3].

The investigations carried out in the second half of nineties supplied the new data on the role of insulin resistance in development the type 2 diabetes mellitus and arteriosclerosis.

In 1997 Stern [37-40] defined new syndrome: "insulin resistance syndrome" including to former 'metabolic Syndrome' hyperuricemia and homeostatic disturbances (Table 3).

1	Type 2 diabetes mellitus, glucose intolerance
2	Microalbuminuria: >20 µg/l
3	Obesity: BMI >30.0, WHR: women >0.85, men >0.9
4	Hyperuricemia
5	Increase concentration of the factors: VII, IX, X
6	Dyslipidemia: TG >1.7 mmol/l

Table 3: The components of the insuline resistance syndrome.

Insulin Resistance Syndrome

In the metabolic pathway of type 2 diabetes mellitus fatty tissue-especially visceral fatty tissue play very important role. The receptor system of fatty tissue involves all hormones: growth hormone-GH, thyroid stimulating hormone-TSH, and three-iodothyronine-T-3, four-iodothyronine-T-4, catechol-amines, tumor necrosis factor-TNF, steroids, and estrogens, as well. It creates the link between endocrine system and fatty tissue metabolism. The group of growth factors: insulin-like growth factor-IGF, interleukines-TNF alfa, and tumor growth factor TGF beta, have also receptors in fatty tissue. Cellules of fatty tissue release some biologically active compounds: thrombin [41], leptin [42,43], resistin [44,45], adiponectine [46,47], and asymmetric dimethylarginine (ADMA) [48]. Especially leptin plays a fundamental role in insulin resistance as a factor simulating insulin secretion and inhibits neuropeptide Y regulating satiate center and in this way increases obesity. Hypertension has multifactor etiology however ADMA, resistine, adiponectin and angiotensinogen increase district arterioles tension leading to hypertension. Increased release thrombin, inhibition anticoagulant factors, hypertension, hyperglycemia and overproduction of insulin create the link between insulin resistance and arteriosclerosis [49,50], cardiovascular complications and increased carcinogenesis [51] observed in obesity in type 2 diabetes mellitus. They are directly connected to the style of life.

Primary prevention of type 2 diabetes mellitus

In many investigations evident relationships of obesity and increased serum insulin level to development of type 2 diabetes mellitus have been confirmed. Therefore normalization of body weight by reduction of calories in diet became a basis for preventive measures against type 2 diabetes mellitus. It has been confirmed in realization of the preventive programs developed as early as in 1978 in the department of Endocrinology UJCM in Krakow [52-60].

According to WHO recommendation, into education program reduction of daily intake of household salt as a risk factor of hypertension- was included [61,62].

The fundamental step towards primary prevention is identification of the persons at risk. The following diagnostic criteria should be applied.

Patient's family history on diagnosed diabetes among the first line family members independently on its etiology.

Anthropometric criteria: BMI >30.0, WHR- women >0.85, men >0.9. 3.2 hours oral glucose (75 g) tolerance test (OGTT). (Normative values: Fasting glucose level ≤140 mg/100ml, 120 min, <200 mg/100ml).

Serum insulin level (normative values: fasting <8.82 ± 6.4 uIU/ml, 120 min (OGTT) <43.99 ± 41.37 uIU/ml).

Serum total cholesterol level (normative value: <200 mg/ml).

The most important test is OGGT, because determinations of fasting glucose concentration do not allow diagnosing all patients with type 2 diabetes mellitus and in around 50% gives false negative value creating a big group of "unknown diabetes". Insulin determination is not obligatory due to methodic problems and every laboratory has to control its own normative values.

The effective model of primary prevention of type 2 diabetes mellitus was elaborated within the Polish Multicenter Study on Diabetes Epidemiology [12] according to following schedule: identification of the patients with high risk of appearing or newly diagnosed type 2 diabetes mellitus, and introducing an education program on the primary health care level (rational dietary habits, increased physical activity, cessation or reduction of smoking and alcohol consumption). The selected group of patients with highest risk of appearing the type 2 diabetes mellitus was qualified to a special 3-weeks preventive program in our SPA system. This system was checked in the group of 16 men and 21 women with newly diagnosed type 2 diabetes mellitus on the basis of OGGT. After 3 months of this program continuation mean reduction of body weight in women was 4.7 kg in men 5.9 kg, in 31% OGTT normalized, and insulin concentration in 120 min. of OGTT diminished in women from 148.8 ± 86.2 to 58.4 ± 41.0, in men from 81.5 ± 52.7 to 41.6 ± 21.0 (uIU/ml). It reflects a real perspective for reduction the prevalence of the type 2 diabetes mellitus on the population level.

Apart from implementation the preventive program we developed evaluation of the economic consequences of this high prevalence of type 2 diabetes mellitus in Poland [63] expressed in direct cost and in specific units: Disability Adjusted Life Years (DALY). The total cost of diabetes in Poland in 1998 accounted for 9.3% of the total public health care expenditures and 112 584 DALYs were lost due to premature deaths and disability-28% and 72% of total respectively. Therefore primary prevention on the population level has great economic aspect as well.

However this preventive model based on changing the style of life, is very difficult to be accepted by the patients, and the control of results after 2 years revealed, that 50% of patients only-were able to continue the program [53].

The effectiveness of the preventive programs based on education, physical activity and reduction the body weight have been confirmed by other authors [64,65]. Global burden of diabetes and prediction on the epidemic growth in the world during the first quarter of 21st century [9] are recognized as an urgent priority. In response to these data national and international preventive programs started [66,67]. Especially DE-PLAN project- Diabetes in Europe-Preventing Using Lifestyle, Physical Activity and Nutritional Intervention coordinated by the Prof. J. Thuomilehto from University of Helsinki integrated 19 European groups around the preventive measures, on line with recommendations of the European Association of the Study of Diabetes, the European Society of Cardiology, International Diabetes Federation and WHO as well. The Polish part of the DE-PLAN represents a very important approach by implementation the screening system and intervention model on the primary health care level [68-72].

The DE-PLAN project provided valuable tool to evaluate the risk of the type 2 diabetes mellitus (T2D) in Europe "Finnish Diabetes Risk Score (FINDRISC)" and allowed to formulate evidence-based guideline for the prevention of type 2 diabetes mellitus in Europe. The project group obtained considerable experience in developing lifestyle interventions aiming at preventing T2D in high-risk individuals [73]. The DE-PLAN project has also formed a basis for the IMAGE project that is currently developing the European guideline for the prevention of T2D [74].

The preventive program IMAGE is developed in line with the WHO Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013-2020 endorsed by the 66th World Health Assembly, focused on risk factors, unhealthy diet and physical inactivity. The European global framework on this field was formulated by WHO Ministerial Conference on Nutrition and Non-communicable Diseases in the Context of Health 2020 in Vienna 5 July 2013 [75].

Conclusion

Epidemiologic investigation undertaken within the last 10 years in the prevalence of type 2 diabetes leads to the following conclusions: 1) The prevalence of type 2 diabetes in Poland has reached an endemic level (2millions of people). 2) Around 50% of patients represent the so-called unknown diabetes-diagnosed for the first time in the course of investigations. 3) The main risk factors of type 2 diabetes are overweight and obesity.

The previous experience concerning the influence of body weight reduction and physical activity on the incidence and development of type 2 diabetes leads to the following conclusions.

Non-pharmacological intervention based on body weight reduction by low--caloric diet, physical therapy and change of lifestyle makes it possible to inhibit the development of type 2 diabetes and to modify its management.

The most effective model of type 2 diabetes therapy is non-pharmacologic intervention on the primary health care level with low-caloric diet and physical therapy. The next step is 2-3 week-long program with low-caloric diet, physical exercise and education in an appropriately prepared resort, and after that, patients are directed again to their general practitioner to continue the treatment.

The criteria for qualifying patients to the non-pharmacologic treatment are as follows:.

The program of non-pharmacologic treatment may be applied to patients of the highest risk group, i.e., with BMI >30.0 and glucose intolerance.

It is possible to qualify patients with diagnosed type 2 diabetes treated with diet or oral anti-diabetic drugs.

It is not allowed to qualify patients treated with insulin, with cardiac abnormalities or receiving some other pharmacologic treatment.

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