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(RESEARCH ARTICLE)

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Intuition on medical nutrition therapy for type 2 diabetes mellitus: an outlook with a case study: A survey

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Abstract

Diabetes is a chronic (long-lasting) health condition that affects how your body turns food into energy. Your body breaks down most of the food you eat into sugar (glucose) and releases it into your bloodstream. When your blood sugar goes up, it signals your pancreas to release insulin. Insulin acts like a key to let the blood sugar into your body's cells for use as energy. With diabetes, your body doesn't make enough insulin or can't use it as well as it should. When there isn't enough insulin or cells stop responding to insulin, too much blood sugar stays in your bloodstream. There are three main types of diabetes: type 1, type 2, and gestational diabetes. Type 1 diabetes is thought to be caused by an autoimmune reaction (the body attacks itself by mistake). This reaction stops your body from making insulin. Approximately 5-10% of the people who have diabetes have type 1. With type 2 diabetes, your body doesn't use insulin well and can't keep blood sugar at normal levels. About 90-95% of people with diabetes have type 2. It develops over many years and is usually diagnosed in adults. Gestational diabetes develops in pregnant women who have never had diabetes. If you have gestational diabetes, your baby could be at higher risk for health problems. Gestational diabetes usually goes away after your baby is born. 96 million adults more than 1 in 3—have prediabetes. More than 8 in 10 of them don't know they have it. With prediabetes, blood sugar levels are higher than normal, but not high enough for a type 2 diabetes diagnosis. Prediabetes raises your risk for type 2 diabetes, heart disease, and stroke. Diabetic Mellitus would be treated in a many way in that Medical Nutrition therapy is one of the main component to treat the diabetic Mellitus. Therefore, this article deals with Nutritional therapy impact on a Type 2 Diabetic Mellitus with some case study.

Keywords: Diabetes; Medical nutrition therapy; Type 2 diabetes mellitus; Case study

1. Introduction

Diabetes mellitus is a metabolic disease that causes high blood sugar. Your body either doesn't make enough insulin or can't effectively use the insulin it makes. The hormone insulin moves sugar from the blood into your cells to be stored or used for energy. If this malfunctions, you may have diabetes. Untreated high blood sugar from diabetes can damage your nerves, eyes, kidneys, and other organs.[1]

1.1. What are the different types of diabetes?

1.1.1. Type 1 diabetes

This type is an autoimmune disease, meaning your body attacks itself. In this case, the insulin-producing cells in your pancreas are destroyed. Up to 10% of people who have diabetes have Type 1. It's usually diagnosed in children and young adults (but can develop at any age). It was once better known as "juvenile" diabetes.

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1.1.2. Type 2 diabetes

With this type, your body either doesn't make enough insulin or your body's cells don't respond normally to the insulin. This is the most common type of diabetes. Up to 95% of people with diabetes have Type 2. It usually occurs in middle-aged and older people. Other common names for Type 2 include adult-onset diabetes and insulin-resistant diabetes.

1.1.3. Prediabetes

This type is the stage before Type 2 diabetes. Your blood glucose levels are higher than normal but not high enough to be officially diagnosed with Type 2 diabetes.

1.1.4. Gestational diabetes

This type develops in some women during their pregnancy. Gestational diabetes usually goes away after pregnancy. However, if you have gestational diabetes you're at higher risk of developing Type 2 diabetes later on in life.[2]

2. Incidence and Prevalence of Type 2 Diabetic Mellitus

Diabetes is estimated to affect 537 million adults worldwide [3]. In an analysis of data from the National Health Interview Survey (2016 and 2017), the prevalence of diagnosed type 2 diabetes among adults in the United States was 8.5 percent [4]. Other national databases, such as the Center for Disease Control and Prevention Diabetes Surveillance System, reported in 2022 a prevalence of diagnosed diabetes of approximately 11.3 percent of adults (37.3 million people, with 28.7 million with diagnosed diabetes, an estimated 8.5 million undiagnosed, and 95 percent of whom have type 2 diabetes)[5-6]. Using data from a national survey for people aged 20 years or older, the prevalence of diagnosed type 2 diabetes in the United States (2018) was 7.5 percent in non-Hispanic White Americans, 9.2 percent in non-Hispanic Asian Americans, 12.5 percent in Hispanic Americans, 11.7 percent in non-Hispanic Black Americans, and 14.7 percent in Native Americans/Alaska Natives [7].

2.1. Causes of Type 2 diabetes

- Type 2 diabetes is primarily the result of two interrelated problems:

Cells in muscle, fat and the liver become resistant to insulin. Because these cells don't interact in a normal way with insulin, they don't take in enough sugar.

The pancreas is unable to produce enough insulin to manage blood sugar levels.

2.2. Risk factors

Factors that may increase your risk of type 2 diabetes include:

- Weight. Being overweight or obese is a main risk.
- Fat distribution. Storing fat mainly in your abdomen — rather than your hips and thighs — indicates a greater risk. Your risk of type 2 diabetes rises if you're a man with a waist circumference above 40 inches (101.6 centimeters) or a woman with a measurement above 35 inches (88.9 centimeters).
- Inactivity. The less active you are, the greater your risk. Physical activity helps control your weight, uses up glucose as energy and makes your cells more sensitive to insulin.
- Family history. The risk of type 2 diabetes increases if your parent or sibling has type 2 diabetes.
- Race and ethnicity. Although it's unclear why, people of certain races and ethnicities — including Black, Hispanic, Native American and Asian people, and Pacific Islanders — are more likely to develop type 2 diabetes than white people are.
- Blood lipid levels. An increased risk is associated with low levels of high-density lipoprotein (HDL) cholesterol — the "good" cholesterol — and high levels of triglycerides.
- Age. The risk of type 2 diabetes increases as you get older, especially after age 35.
- Prediabetes. Prediabetes is a condition in which your blood sugar level is higher than normal, but not high enough to be classified as diabetes. Left untreated, prediabetes often progresses to type 2 diabetes.
- Pregnancy-related risks. Your risk of developing type 2 diabetes increases if you developed gestational diabetes when you were pregnant or if you gave birth to a baby weighing more than 9 pounds (4 kilograms).

- Polycystic ovary syndrome. Having polycystic ovary syndrome — a common condition characterized by irregular menstrual periods, excess hair growth and obesity — increases the risk of diabetes
- Areas of darkened skin, usually in the armpits and neck. This condition often indicates insulin resistance. 8

2.3. Signs and Symptoms

Symptoms of Type 2 diabetes tend to develop slowly over time. They can include:

- Blurred vision.
- Fatigue.
- Feeling very hungry or thirsty.
- Increased need to urinate (usually at night).
- Slow healing of cuts or sores.
- Tingling or numbness in your hands or feet.
- Unexplained weight loss.9

2.4. What are the complications of high blood sugar levels?

Potential complications of high blood sugar levels from Type 2 diabetes can include:

- Digestive problems, including gastroparesis.
- Eye problems, including diabetes-related retinopathy.
- Foot problems, including leg and foot ulcers.
- Gum disease and other mouth problems.
- Hearing loss.
- Heart disease.
- Kidney disease.
- Liver problems, including nonalcoholic fatty liver disease.
- Peripheral neuropathy (nerve damage).
- Sexual dysfunction.
- Skin conditions.
- Stroke.
- Urinary tract infections and bladder infections.10

3. Case report 1

3.1. Patient ID

Ms. L, 17 years and 5 months, female

3.2. Complaints

Polydipsia, polyuria

3.3. Family history

Mother with hypertension, father with heart failure.

3.4. History of present illness

This 17-year-old girl was diagnosed with diabetes at another hospital after a 1-month history of persistent polydipsia and polyuria. She presented to Konkuk University Medical Center for further diagnosis and treatment of her persistent symptoms.

3.5. Physical examination

On admission, her height was 173.1 cm (>97th percentile), weight was 107.2 kg (>97th percentile), and BMI was 35.8 kg/m2 (>97th percentile) She appeared obese but did not look ill and her mental status was intact. Her vital signs were normal except for a blood pressure of 137/81 mmHg (95–99th percentile). Her skin was warm and no dry mucous membranes were observed. A chest examination was unremarkable. No enlargement of the liver or spleen was appreciated on an abdominal examination. The rest of the physical exam was unremarkable.

3.6. Lab findings

Labs on admission revealed a glycated hemoglobin (HbA1c) of 11.1%, fasting plasma glucose level of 102 mg/dL, insulin level of 23.12 μIU/mL, and C-peptide level of 4.13 ng/mL. Liver function tests revealed an elevated serum aspartate transaminase (AST) level of 115 IU/L and serum alanine transaminase (ALT) level of 141 IU/L. A lipid panel demonstrated a total cholesterol level of 133 mg/dL, triglycerides of 71 mg/dL, and high-density lipoprotein cholesterol (HDL-C) of 49 mg/dL . The total protein and albumin level was 7.0 g/dL and that of albumin was 4.5 g/dL. The free fatty acid level was elevated at 1214 μEq/L.

3.7. Treatment and progress

For glycemic control, the patient was started on oral medications (metformin 500 mg BID, glimepiride 1 mg QD) as well as a diet and exercise program as a lifestyle modification. Her dietary and nutritional knowledge were evaluated, and she was counseled to have regular meals with 70–75 g of proteins per day and maintain daily nutritional requirements of approximately 1,800 kcal. She was recommended to consume a low-carb, low-fat diet, limit high saturated fats, track her intake, and attend outpatient appointments every 1–2 months. She was instructed to perform aerobic and weight exercises that improve muscle strength for more than 1 hour at least 3 times per week. For 1 year, she did aerobic and anaerobic exercises for an hour or more per day. After 1 year, she incorporated a 7 km walk daily and Pilates more than 3 times per week to her exercise program. In the outpatient setting, we assessed her adherence to therapy at 1–2 month intervals, offered motivational support, and advised her to gradually increase her exercise duration rather than intensity. We measured her height and weight every year and used InBody720, a type of bioelectrical impedance analysis (BIA), to accurately evaluate her obesity. On diagnosis, the patient's BMI was 35.8 kg/m2 (FMI, 18.0 kg/m2; FFMI, 17.8 kg/m2), scoring >97th percentile, and percent body fat (PBF) was 50.4%. During the 2 years of outpatient monitoring, she had no difficulty controlling her blood sugar level using the combination of oral medication and lifestyle modification. However, the dose of metformin was increased to 1,000 mg BID due to difficulty maintaining her HbA1c <7.0% on the previous regimen; at that time, she was still considered obese with a BMI of 35.1 kg/m2 (FMI, 17.2 kg/m2; FFMI, 17.9 kg/m2) and PBF of 48.9%. Her weight and body composition during treatment. Three years later, the patient's dietary therapy and exercise program resulted in an increased FFMI at 18.3 kg/m2 and reduced FMI at 14.9 kg/m2, leading to discontinuation of the glimepiride and a reduction in the metformin dose to 500 mg BID. Four years later, her HbA1c decreased to 5.4% and the metformin was discontinued due to her successful glycemic control. At that time, her fasting blood glucose level was 97 mg/dL, insulin level was 5.62 μIU/mL, and C-peptide level was 2.13 ng/mL. Her BMI was 27.1 kg/m2 (FMI, 10.3 kg/m2; FFMI, 16.8 kg/m2) and PBF was 38.2%, which is still considered obese based on the World Health Organization diagnostic criteria for Asian adults; however, it was 8.7 kg/m2 less than her BMI prior to treatment and her FMI had decreased by 7.7 kg/m2. Her FFMI was also reduced by 1.0 kg/m2, but still belonged to the 90–95th percentile; thus, her nutritional status was not a concern . Liver function tests and a lipid panel revealed AST 20 IU/L, ALT 12 IU/L, total cholesterol 114 mg/dL, triglycerides 59 mg/dL, and HDL-C 51 mg/dL . Her HbA1c has remained at <5.7% for more than a year without oral medications and will continue to be followed.

4. Case 2

4.1. Patient ID

Ms. A, 12 years and 10 months, female

4.2. Complaints

Hyperglycemia

4.3. Family history

Father with type 2 diabetes under treatment

4.4. History of present illness

12-year-old female who presented to Konkuk University Medical Center with post-prandial hyperglycemia of 330 mg/dL measured by her father one day prior to admission. Menarche occurred 1 year prior and her menstrual cycles were regular.

4.5. Physical examination

On admission, the patient's height was 158.9 cm (25–50th percentile), weight was 75.5 kg (>97th percentile), and BMI was 29.9 kg/m2 (>97th percentile) . Her vital signs were within the normal range with a blood pressure of 112/68 mmHg, pulse of 72 beats/min, respiratory rate of 20 breaths/min, and temperature of 36.6°C. She had a clear mental status, warm skin, and moist mucous membranes. A chest examination revealed no specific findings, while an abdominal examination revealed no hepatomegaly or splenomegaly. The rest of the physical examination was unremarkable.

4.6. Laboratory findings

Laboratory tests at the time of admission revealed an HbA1c level of 9.9%, fasting blood glucose level of 202 mg/dL, insulin level of 15.85 μIU/mL, and C-peptide level of 2.97 ng/mL. Liver function tests showed an elevated AST level at 47 IU/L and ALT level at 69 IU/L. A lipid panel and comprehensive metabolic panel showed a total cholesterol level of 165 mg/dL, triglyceride level of 104 mg/dL, HDL-C of 50 mg/dL, total protein of 7.6 g/dL, and albumin of 4.8 g/dL . The free fatty acid level was elevated at 671 μEq/L.

4.7. Radiologic finding

There were no significant findings on a chest radiograph. An abdominal ultrasound showed moderate fatty liver.

4.8. Treatment and progress

For glycemic control, combination therapy of oral medication (metformin 500 mg BID) and lifestyle modification through adjustments in dietary habits was prescribed. We evaluated her dietary and nutritional knowledge and then counseled her to consume regular meals with 70–90 g of protein per day, maintain daily nutritional requirements of approximately 1800 kcal, and eat a low-carb, low-fat diet. She was recommended to modify her habitual preference of salty and spicy foods, reduce her salt intake, track her meals, and attend outpatient monitoring appointments every 1–2 months. For an exercise program, she was instructed to include aerobic and weight exercises that improve muscle strength. She was advised to walk >1 hour at least 5 days per week and visit a health training center for ≥1 hour of strength exercises at least 3 times per week. We measured her height and weight every 2 months, and used InBody720, a type of BIA for accurate assessment of obesity. On diagnosis, patient's BMI was 29.9 kg/m2 (FMI, 12.7 kg/m2; FFMI, 17.2 kg/m2) and PBF was 42.5%. Two years later after the diagnosis, an abdominal ultrasound showed improvements in her fatty liver and her HbA1c was successfully reduced to 6.0%. The oral medication was discontinued due to the successful glycemic control. At the time, her fasting blood sugar was 97 mg/dL, insulin level was 5.62 μIU/mL, and C-peptide level was 2.79 ng/mL. Her BMI (FMI+FFMI) was 23.2 kg/m2 (7.0 kg/m2+16.2 kg/m2), which was within the overweight range (85–90th percentile), and her PBF was 30.2%. Her BMI at that point was 6.7 kg/m2 lower than that prior to therapy, with a 5.7 kg/m2 reduction observed in her FMI. Liver function tests and a lipid panel revealed the following: AST, 20 IU/L; ALT, 34 IU/L; total cholesterol, 115 mg/dL; triglycerides, 70 mg/dL; and HDL-C, 30 mg/dL . The changes in the patient's weight and body composition during treatment. Since discontinuing the oral medication, the patient has maintained an HbA1c level <6.5%.[11]

5. Discussion

The prevalence of type 2 diabetes is increasing with changes in dietary habits and increases in the incidence of obesity among children and adolescents. Although it is already known that a reduced caloric intake and weight loss through lifestyle modifications can treat diabetes, few cases demonstrating such an effect have been reported to date.[12] As discussed previously in two cases, a notable reduction in FM resulted in an HbA1c level <6.5% and improved glycemic control as well as successful maintenance of HbA1c at goal level without medications. According to the 2009 consensus statement reported by the American Diabetes Association, a complete response is defined as blood sugar in the normal range for >1 year without any medications (fasting blood sugar <100 mg/dL, HbA1c <5.7%). Partial response is defined as a blood sugar level below the diabetes range for >1 year without any medications or medical procedures (HbA1C <6.5%; fasting blood sugar, 100–125 mg/dL).[13] In the two cases presented above, significant decreases in BMI and PBF were observed as well as subsequent improvements in HbA1c and fasting blood sugar level.A recent study reported that oral medication was eventually needed to control hyperglycemia in patients with diabetes refractory to management with proper lifestyle modification.14 However, lifestyle modification is important, and is a cornerstone in the treatment

of diabetes, and it should be a mandatory treatment for type 2 diabetes. In females, it is common to see an increase in PBF with progression of puberty.15-16However, here we report cases of complete remission of diabetes in teenage girls with lifestyle modification and emphasize once again that intensive lifestyle improvement is an effective early treatment for diabetes.[17]Our results demonstrate that intensive lifestyle modification including regular exercise and dietary changes is very effective in the treatment of obese patients with type 2 diabetes.

6. Conclusion

Medical Nutritional Therapy is an effective and affordable therapeutic approach that should be made an indispensable component of T2DM prevention and management. It is a complex process, which involves tailoring of diet plans based on the individual's metabolic Pathophysiology (prediabetes, early or late T2DM) to provide adequate nutrients and calories while accommodating the individual's culinary practices and eating patterns. Appropriate MNT should be devised and monitored by a team of RDs and dialectologists based on their experience and the patient's previous diet history, blood glucose levels and presence of co morbidities to ensure best care. The recommendations and strategies provided in this document should be adopted within the context of current clinical practice and at the discretion of the RDs and dialectologists. Overall, MNT should provide convenient and culturally oriented choices that will motivate individuals to engage in healthful dietary habits.

Compliance with ethical standards

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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