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THE EFFECT OF OLIVE OIL ON DIABETICS PATTERN

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By Muaamar Salim Jasim ALABDAL

January 2022

We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science

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Muaamar Salim Jasim ALABDAL

ABSTRACT

THE EFFECT OF OLIVE OIL ON DIABETICS PATTERN

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January 2022

A study has been carried out on the efficacy of olive oil in patients with type 2 diabetes mellitus, with the aim of reducing hyperglycemia levels. Patients attended to Basrah medical College, who have this disease were chosen, a population with high risk of contracting other chronic diseases (risk cardiovascular disease, rhinopathy, diabetic nephropathy etc.). The study was conducted on 150 people. Treatment was performed on 120 of them, duly diagnosed with type 2 diabetes mellitus by the medical personnel. The biochemical determination of glycemia was performed by enzymatic method, and the t-student and Kolmogórov tests were applied as a statistical method. For the treatment with Olive Oil, the dose of 20g was used in the form of salad, only once a week for a period of 3 months. At the end of this period, it was observed that the 120 patients considered in the study decreased glucose levels. Before and after laboratory determination ranged from 142.78 mg/ dL to 85.15 mg/ dL. As a control group, 5 patients who abandoned treatment for work reasons and other activities were considered. The glucose level was measured before and after, finding that the values had not decreased, compared to those who did undergo the treatment with olive oil.

2022, 91 pages

Keywords: Olive oil, Cardiovascular, Diabetes mellitus, Glucose

ÖZET

ZEYTİNYAĞININ DİYABET HASTALARINA ETKİSİ

Muaamar Salim Jasim ALABDAL

Kimya, Yüksek Lisans

Tez Danışmanı: Doç. Dr. Hakan ÇOLAK

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Ocak 2022

Zeytinyağının tip 2 diyabetli hastalarda hiperglisemi düzeylerini düşürmeye yönelik etkinliği üzerine bir çalışma yapılmıştır. Basra Tıp Fakültesine başvuran ve bu hastalığa sahip olan hastalar, diğer kronik hastalıklara (kalp-damar hastalığı, rinopati, diyabetik nefropati vb.) yakalanma riski yüksek olan bir popülasyon seçilmiştir. Araştırma 150 kişi üzerinde yapıldı. Sağlık personeli tarafından usulüne uygun olarak tip 2 diyabet tanısı konulan 120 hastaya tedavi uygulanmıştır. Gliseminin biyokimyasal tayini enzimatik yöntemle, istatistiksel yöntem olarak t-student ve Kolmogórov testleri uygulandı. Zeytinyağı ile tedavide 3 ay süreyle haftada sadece bir kez olmak üzere 20 gr'lık doz salata şeklinde kullanılmıştır. Bu sürenin sonunda çalışmada değerlendirilen 120 hastanın glukoz düzeylerinin düştüğü gözlenmiştir. Laboratuvar belirleme öncesi ve sonrası 142, 78 mg/dL ile 85, 15 mg/dL arasında değişmektedir. Kontrol grubu olarak iş ve diğer aktiviteler nedeniyle tedaviyi bırakan 5 hasta alınmıştır. Glikoz seviyesi, Zeytinyağı tedavisi görenlere kıyasla değerlerin düşmediği tespit edilerek önce ve sonra ölçülmüştür.

2022, 91 sayfa

Anahtar Kelimeler: Zeytinyağı, Kardiyovasküler, Diabetes mellitus, Glikoz

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Muaamar Salim Jasim ALABDAL
Çankırı-2022

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LIST OF SYMBOLS

%	Percentage
±	Plus-minus
µg	Microgram
µL	Microliter
g	Gram
mg	Miligram
mL	Mililiter
ng	Nanogram
nm	Nanometer

LIST OF ABBREVIATIONS

ADA	American Diabetes Association
MI	Myocardial infarction
CVA	Cerebrovascular accident
CVD	Cardiovascular disease
DCCT	Diabetes control and complications trial
DM	Diabetes mellitus
T2DM	Type 2 diabetes mellitus
EVOO	Extra virgin olive oil
FHP	Family Health Program
HbA1c	Hemoglobin A1C
IDF	International Diabetes Federation
MFA	Monounsaturated fatty acids
NGSP	National Glycohemoglobin Standardization Program
NHANES	National Health and Nutrition Examination Survey
WHO	World Health Organization

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1. INTRODUCTION

Diabetes is a metabolic disease characterized by high levels of glucose in the blood, secondary to an absolute or relative alteration in insulin secretion. Chronic hyperglycaemia is accompanied by changes in carbohydrate, lipid, and protein metabolism. The most characteristic symptoms are polydipsia, polyphagia, polyuria, and blurred vision (Kerner and Brückel 2014).

In Iraq, a recently published article demonstrated that the isolated use of HbA1c for the diagnosis of DM identifies a different population of patients when compared to fasting glucose and / or glucose tolerance test, and may not be sufficient for the correct diagnosis of DM. This article suggests that the use of algorithms employing the fasting glycemia, glucose tolerance test and / or A1c tests may be more appropriate to guarantee the correct classification of individuals with DM (Nelson *et al.* 2002, Ong *et al.* 2010). Demonstrated that variations in HbA1c results regarding the laboratory methodology used can lead to significant differences in the management of patients with DM, unless governments and medical societies work together to build a national HbA1c standardization program, the clinical decision will still have high levels of uncertainty generated by methodological problems.

Diabetes mellitus is increasing its incidence and prevalence, in recent years made an estimate in 2008 regarding the global number of diabetic patients in the world (Zhang *et al.* 2008), calculating that it may reach 366 million people by 2025, mainly at the expense of type 2 DM. Interestingly, among countries "Top ten" in terms of DM growth are India, China, Indonesia, Pakistan or Bangladesh, next to "developed" countries such as USA, Italy and Japan. The repercussions of DM on the health of the population are based on a high prevalence, which implies a high socio-economic cost, due to the appearance over time of numerous micro and macrovascular complications as the natural history of the disease progresses. All of this will imply a tremendous comorbidity that will lead to very high mortality rates in this population.

This study selected volenturs (Patients) suffered from type II Diabetes Mellitus in one of the capital city located in south of Iraq. The selection of participants was carried out from the records of diabetic patients obtained from the teams of the Family Health Program (FHP).

This study aimed to describe the characteristics of a given population, in addition to identifying possible relationships between variables, the survey method that used in the present study is characterized by the direct interrogation of people whose behaviour want to know. Basically, a significant group of people is asked to provide information about the problem studied, and then, through quantitative analysis, to obtain the conclusions corresponding to the data collected. This study will be one of the few ones in this field, thus, it will be a valuable contribution to the literature.

2. LITERATURE REVIEW

2.1 Definition of Pre-Diabetes, Diagnostic Criteria and Screening Indications

In 1997 and 2003, the expert committee on the diagnosis and classification of diabetes mellitus recognized an intermediate group of individuals whose glucose levels, although they do not meet the criteria for diabetes mellitus (DM), are elevated to be considered normal. This group was defined as impaired fasting glucose and impaired glucose tolerance, being considered intermediate stages in the natural history of DM2, now known as pre-diabetes. Impaired fasting glucose is diagnosed by blood glucose after 8 hours of fasting. Impaired fasting glucose can only be identified by performing an oral glucose tolerance test. As standardized by the World Health Organization (WHO), in this test blood glucose is collected after fasting for 8 hours and new collection is performed after 2 hours of ingestion of 75g of glucose. During the test, the patient must not exercise or smoke and, in the three days before the test, the intake of carbohydrates should not be less than 150g, since diets with smaller amounts can cause false-negative results (Harries *et al.* 2013).

More recently, the American Diabetes Association (ADA) endorsed the use of glycated hemoglobin (HbA1c) as a diagnostic method for DM and pre-diabetes (Fonseca *et al.* 2012). After an extensive review of epidemiological evidence, the international expert committee defined the standardized methods of measuring HbA1c that can be used for its measurement. The measurement of HbA1c must be performed using a method certified by the national glycohemoglobin standardization program (NGSP) and standardized according to the references of the Diabetes Control and Complications Trial (DCCT). Values equal to or above 6.5% are considered for the diagnosis of DM. HbA1c has many advantages over fasting glycemia for the diagnosis of DM, including greater convenience (since fasting is not necessary), greater pre-analytical stability and less daily variation during periods of stress or illness. However, these advantages must be weighed against the high cost, the lower availability of the test in certain regions of developing countries and the lower correlation between HbA1c and mean blood glucose in certain individuals. A study by the national health and nutrition examination survey (NHANES)

demonstrated that, in a population of non-diabetic adults, fasting blood glucose of 110mg / dL corresponds to an HbA1c of 5.6%, and that of 100mg/ dL corresponds to an HbA1c of 5.4%. The analysis of these data showed that an HbA1c value of 5.7%, when compared to other cutoff points, has the best combination of sensitivity 39% and specificity 91% to identify individuals (Hoerger *et al.* 2008). Thus, one can consider individuals with HbA1c between 5.7% and 6.4% as being at high risk for future DM and also apply the term pre-diabetes to them. On the other hand, the low sensitivity of the test is one of the arguments against its use in clinical practice (Zhang *et al.* 2017). The cutoff points established for HbA1c to detect high-risk individuals will identify about 12% of the adult population in the United States; this number is significantly lower than that identified by fasting blood glucose 25%. In Mexico, as in other developing countries, the absence of a standardization program for HbA1c discourages its use as a diagnostic method (Fonseca *et al.* 2012).

2.2 Importance of Diabetes Mellitus

Type 2 Diabetes Mellitus (T2DM) is a pathology with high morbidity and mortality. Its morbidity is fundamentally determined by microvascular complications. In the general population, the diabetic patient has a 40 times greater risk of amputation, 25 times greater of end-stage renal failure, 20 times greater of blindness, 2 and 5 times greater of Cerebrovascular Accident (CVA) and between 2 and 3 times greater of acute Myocardial Infarction (AMI). However, its mortality is basically due to macrovascular complications, which may be present before the diagnosis of the disease. In the United States, about 40% of diabetic patients die from AMI, 15% die from another heart disease, and 10% die from stroke. The foregoing poses a serious public health problem if one considers that in 2010 the diabetic population is expected to double its number compared to 1994 and reach nearly 240 million people worldwide (Deshpande and Harris 2008).

Possibly not one but several causes that explain this trend, but the increase observed in the prevalence of obesity in recent years seems very important. Epidemiological studies have observed a clear association between weight gain in the United States population and the prevalence of T2DM. In this same sense, some researchers have suggested that

although both insulin resistance and the secretory deficit of the pancreatic beta cell contribute to the pathogenesis of T2DM, the former would be the factor that confers the greatest risk (Johnson *et al.* 2014).

In accordance with the foregoing, in recent years various studies have been published evaluating the possibility of preventing or delaying the onset of T2DM through strategies aimed mainly at reducing insulin resistance. They include both non-pharmacological interventions as well as the use of various classes of drugs used in the treatment of T2DM and obesity: insulinosensitizers (metformin and troglitazone), alpha-glucosidase inhibitors (acarbose), and gastrointestinal lipase inhibitors (orlistat). Studies on the prevention of cardiovascular morbidity and mortality have shown a reduction in the incidence of T2DM with the use of angiotensin converting enzyme inhibitors, angiotensin II type 1 receptor antagonists, calcium channels, statins, and hormone replacement therapy.

2.3 Methods, Principles and Criteria for Screening

Most pre-DMI and DMII screening methods include several steps. They usually start with the application of questionnaires on risk factors. There are several proposals for questionnaires in the literature, and it is suggested to try to adapt the instrument to the local reality in order to have a list of universal factors, complemented by some specific ones; that specific weights are assigned to these factors, and that different cutoff points are defined, in order to maximize their performance, sensitivity and specificity. The second stage is usually represented by capillary blood glucose tests, and the third and last stage, by fasting blood glucose, glycated hemoglobin (HbA1c) or glucose tolerance tests. These methods are well accepted and recommended, and have a very favorable cost-benefit ratio.

The utility of applying questionnaires on risk factors is controversial because it has had a low positive predictive value, that is, a high proportion of false positives, which restricts its action in reducing costs. On the other hand, they have high sensitivity (low rate of

false-negatives), which makes them indisputably useful in multi-step approaches (Agwu 2008).

2.4 Diagnosis

Currently, there are three diagnostic criteria for DM2, through the measurement of glycemia, accepted by the American Diabetes Association (ADA), World Health Organization (WHO): casual blood glucose greater than 200mg / dL added to the presence of classic symptoms, fasting blood glucose equal to or greater than 126mg / dL, or even after two hours of overload with 75g of glucose greater than or equal to 200mg /dL.

In July 2009, the use of glycated hemoglobin (HbA1c) was proposed as a diagnostic criterion for DM, as it assesses the degree of exposure to glycaemia over time and the values remain stable after collection. It is a diagnostic criterion, when HbA1c is greater than or equal to 6.5% 6. Individuals with HbA1c between 5.7 and 6.4% have a high risk of developing DM (the value of 5.7 has a sensitivity of 66% and a specificity of 88% to predict the development of DM in the subsequent 6 years) (Ali *et al.* 2018).

There is an intermediate group of individuals for whom blood glucose levels do not meet the diagnostic criteria for T2DM. However, they are also not normal, and may be called pre-diabetes (pre-DM). In these cases, when fasting blood glucose is between 100 and 126mg / dL, it is classified as altered fasting blood glucose; or when, after 120 minutes of an oral overload of 75g of glucose, the glycemia value is between 140 and 199mg / dL, it is called decreased glucose tolerance (Ali *et al.* 2017).

2.5 Current Situation

DM2 is one of the chronic diseases that currently most concern those responsible for public health in the world, because, in 2013, according to data from the International Diabetes Federation (IDF), for the age group of 20 to 79 years old: there were 382 millions of people worldwide diagnosed with DM (Prevalence equal to 8.3%); the number of

people with the disease without a diagnosis was approximately half the number of known cases; 316 million (6.9%) diagnosed with pre-DM; 5.1 million deaths were related to DM; most diabetics were between 40 and 59 years old; and more than $ 548 billion was spent on health services for diabetes. More than 80% of deaths from DM occur in low and middle income countries. The World Health Organization (WHO) projects that, in 2030, this disease will be the seventh leading cause of death. The IDF estimates that in 2035, 592 million cases will be known. In addition to DM, the pre-DM condition is also a cause of concern for public health, as these patients are at high risk of developing DM, as well as at increased risk for the occurrence of cardiovascular diseases.

In 2013, Iraq ranked fourth on the list of number of people diagnosed with DM (aged 20 to 79 years), totaling about 12 million individuals. The estimated prevalence was 9% in individuals between 20 and 79 years old, with approximately 3% more cases in undiagnosed individuals. The average spending on this disease in the past year was $ 1,477 per patient. It is estimated that, in 2030, the number of known cases of DM will reach 19.6 million. Despite the massive expense, there is great inequity in financing and health care for type 2 diabetic patients, observed when comparing geographic regions, socioeconomic categories, genders, age or colour. There is a large number of countries that develop National Programs for T2DM control, with preventive actions and treatment, Iraq among them. They receive support from international organizations, thus constituting a global network for a worldwide program with regional developments. However, important flaws in the diagnosis are described, which tends to be late, in adherence to treatment programs, and deficiencies in comprehensive care.

2.6 Classification of Diabetes

The current diabetes classification is as follows:

- Diabetes type 1.
- Type 2 diabetes.
- Gestational diabetes.
- Other types of diabetes.

2.6.1 Diabetes type 1

Type 1 diabetes is characterized by a destruction of the B cells of the pancreas, leading to a total deficiency in insulin secretion. It can be autoimmune or idiopathic. The autoimmune is known as insulin-dependent or juvenile diabetes. It is more common in children and adolescents. The cause of the destruction of pancreatic cells are autoimmune mechanisms of unknown origin, but they seem to depend on two factors: a genetic predisposition and a triggered mechanism that could be produced by viral infections or stress. The autoimmune reaction produces an inflammation in the islets characterized by the presence of active T cells, which gradually destroy the B cell. Idiopathic is rare, affecting individuals of African and Asian origin9. Insulin-dependent diabetes mellitus is one of the most prevalent chronic non-communicable diseases in children. Although its treatment is standardized, the economic burden for the individual who suffers it is extremely high. Type 2 diabetes: Known as non-insulin dependent or adult diabetes. The etiology of this type of diabetes is unknown and, although there does not appear to be a mechanism for autoimmune destruction, there is a genetic predisposition. Patients have insulin resistance and generally a relative deficiency of this hormone.

Diabetes mellitus can cause multiple microvascular complications in the eyes, kidney, and lower extremities, as well as peripheral and central neuropathies, and frequently macrovascular and coronary lesions. Diabetes is associated with the risk of cardiovascular disease and premature death; blindness; kidney infections and lower limb amputations; polyneuritis; and cerebrovascular diseases.

Most type 2 diabetics are overweight or obese, which contributes to an increase in insulin resistance. It is a type of diabetes that presents variable degrees of insulin deficiency and peripheral resistance to the action of insulin. In diabetes mellitus (T2DM), high levels of compensatory initial insulinemia frequently occur, eventually causing insufficient insulin secretion to compensate for insulin resistance. Among the chronic complications associated with this disease are retinopathy, coronary artery disease, neuropathy, and peripheral ischemia. Diabetic retinopathy is the leading cause of blindness in the West after 15 years of evolution of diabetic disease. Blindness affects 2% of patients, while

another 10% have severe visual problems. Cardiovascular disease, which originates from diabetic macroangioplasty, causes 75% of the deaths of diabetic patients in industrialized countries.

Microvascular complications are directly related to the state of sustained hyperglycemia, although this relationship with macrovascular complications is not yet clear. These can occur with blood glucose levels of 126 mg / dL or less. The metabolic crisis that causes the onset of diabetes can be activated even without the disease manifesting clinically.

Diabetes mellitus is a health problem that affects between 2 and 5% of the world's population. The Declaration of the Americas on Diabetes states that when this disease is poorly controlled, it can represent a heavy social and economic burden for the individual and society, but that it is possible to prevent the disease and complications in people who already have it have good glycemic control (Reinehr 2013).

Education about diabetes is important, because it allows informing, motivating and strengthening those affected and their families to control, prevent or delay complications within the family.

Type 2 diabetes mellitus constitutes a growing public health problem, only in middle east, where there are around 15 million people suffering from the disease. The metabolic crises or acute complications that can appear in a diabetic are ketoacidotic coma, hyperosmolar coma and hypoglycemia. Ketoacidotic diabetic coma is the result of insulin-dependent diabetic decompensation.

2.6.2 Diabetes type 2

It is more common than type 1, making up about 90% of all diabetes cases. It is a heterogeneous entity, characterized by disorders of insulin action and secretion, with a predominance of one or the other component. The specific etiology of this type of diabetes

is not yet clearly established as in type 1 diabetes. The autoimmune destruction of the pancreas is not involved. Also, unlike type 1 diabetes, most patients have obesity.

The age of onset of type 2 diabetes is variable, although it is more frequent after 40 years of age, with a peak incidence around 60 years. In Finns, 97% of type 2 patients start diabetes after 40 years of age. Studies that combine obesity with age over 40 years indicate this age cutoff point as discriminatory between the two types of diabetes. On the other hand, other authors associate the absence of an acute episode of ketoacidosis and age over 20 years as indicators of the presence of type 2 diabetes. Therefore, age alone does not seem to define the classification, but combined with other variables such as obesity and the absence of ketoacidosis may suggest the type of diabetes. It must be taken into account that, the occurrence of familial aggregation of diabetes is more common in type 2 diabetes than in type 1. However, recent studies describe a two-fold higher prevalence of type 1 diabetes in families with type 2, suggesting a possible genetic interaction between the two types of diabetes (Lin *et al.* 2020).

The differentiation between the two most common types of diabetes is generally relatively simple and is based primarily on clinical data.

2.6.3 Gestational diabetes

Gestational diabetes occurs by decreasing the sensitivity of tissues to insulin. This is because ovarian hormones and placentas decrease insulin sensitivity, because the mother must secrete more insulin's to maintain adequate glucose levels. Gestational diabetes is suffered by 2% of pregnant women, generally during the third trimester of pregnancy. This situation disappears after delivery. They are more likely to develop diabetes in subsequent deliveries or at later ages.

Among the factors that contribute to the risk of gestational diabetes are pregnancy after age 35 and obesity. Among the main risk factors for diabetes are obesity, physical inactivity, and excess consumption of animal fats, among others. Controlling them has

been shown to help prevent diabetes or, failing that, to delay complications in patients who suffer from it (Arnold *et al.* 2015).

2.6.4 Other types of diabetes

2.6.4.1 Genetic defect in the action of insulin

It is produced by mutations in the insulin receptor gene or post-receptor alterations. Metabolic abnormalities associated with insulin receptor mutations can range from hyperinsulinemia and mild hyperglycemia to severe diabetes. Some people with these mutations may have acanthosis nigricans. Women can become virilized and have cystic enlargement of the ovaries (Singh *et al.* 2016).

2.6.4.2 Diseases of the exocrine pancreas

It is a process that affects the pancreas, damages it diffusely and can cause diabetes. It includes pancreatitis, trauma, infection, pancreatectomy, and carcinoma of the pancreas. With the exception of damage caused by cancer, pancreatic damage must be extensive for diabetes to occur; adenocarcinomas that involve only a small part of the pancreas have been associated with diabetes. This implies a mechanism that is not the simple reduction in cell mass (Norhammar *et al.* 2008).

2.6.4.3 Drug- or chemical-induced diabetes

They are medications such as corticosteroids or diuretics, which can affect insulin secretion. They do not cause diabetes on their own, but rather can trigger diabetes in individuals with insulin resistance. Certain toxins, such as vacor (a rat poison) and intravenous pentamidine, can destroy S cells. Reactions to medications are rare.

2.7 Diabetes Prevention

Non-pharmacological therapeutic interventions represent a fundamental pillar in the treatment of patients with type 2 diabetes (T2DM) and for this purpose, two classically known strategies (nutrition, lifestyle and physical activity) and a third (bariatric surgery) must be considered. Recently incorporated, which will be the subject of an exhaustive review in this section.

2.7.1 Nutritional treatment in DM2

The general nutritional recommendations are directed towards:

- Prevention (obesity and prediabetes), whose objective is to reduce the risk of diabetes and Cardiovascular Disease (CVD) by promoting physical activity and healthy nutritional habits that result in a moderate weight loss that is maintained or, at a minimum, prevent the gain weight.
- Nutritional therapy in diabetes mellitus (DM), whose goal is to treat and prevent complications through the care and maintenance of optimal metabolic control that includes blood glucose levels, HbA1c, LDL-C, HDL-C and triglycerides, blood pressure and body weight.
- Nutritional strategy in diabetic complications (nephropathy, CVD, dyslipidemia, arterial hypertension [HBP]).
- Obesity and Prediabetes (Shi 2016): Those individuals with prediabetes, obesity, or insulin resistance should receive specialized nutritional care, preferably by nutritionists trained in the treatment of this condition (level of evidence A). A modest decrease in weight (7-10%) improves insulin resistance levels in these subjects, reducing the risk of diabetes progression (level of evidence A).
- Caloric Balance, Overweight and Obesity: The moderate decrease in weight in insulin-resistant subjects with overweight and obesity improves insulin resistance, therefore

weight loss is recommended in all those in this situation due to their higher risk of diabetes (level of evidence A).

- The caloric calculation must be established according to body weight, if the goal is to reduce 25 calories per kg of weight are calculated. For maintenance of body weight from 30 to 35 calories / kg and in lean individuals, children, and adolescents and with special needs > 35 calories / kg.
- Diets highly restricted in carbohydrates and calories can be effective for weight loss in periods of no more than 1 year (level of evidence A). In order to implement a carbohydrate-restricted diet, the lipid profile, renal function, and protein intake should be monitored in individuals with renal disease and hypoglycemic therapy should be adjusted as necessary (level of evidence E).
- Physical activity and behaviour modification should be included in weight loss and maintenance programs (level of evidence B).

2.7.2 Nutritional therapy

a) Insulin-requiring type 2 diabetes

- Integrate the insulin regimen into the patient's lifestyle.
- Total carbohydrate content is the main determinant of pre-meal rapid insulin action and glycemic response.
- Educate the patient on the insulin / carbohydrate ratio to vary the food selection and the corresponding pre-meal insulin dose in a planned way. The amount of insulin required to cover the habitual consumption of carbohydrates during a euglycemic period is established, calculating the ratio of units of insulin /grams of carbohydrates.
- In people who have fixed insulin regimens, consistency in carbohydrate consumption is recommended.

b) Non-insulin-requiring type 2 diabetes

- Emphasize lifestyle changes (diet, physical activity and education) that improve the control of hyperglycemia, dyslipidemia and hypertension.
- Implement the changes simultaneously with the diagnosis of DM or test for abnormal glucose tolerance (prediabetes).
- Due to its high association with obesity, weight loss and abdominal fat result in better control of metabolic parameters.
- It is suggested to reduce 500 - 1000 calories from usual consumption, accompanied by physical activity for long-term achievements.
- Educate in the selection of habitual and occasional foods, together with glycemic self-control.

2.7.3 General recommendations on the feeding components

(a) Fats, fatty acids and cholesterol

- The contribution of saturated fat should be less than 7% of total calories. The decrease in the consumption of "trans" fats manages to lower LDL-C and increase HDL-C (level of evidence A).
- Daily cholesterol intake should be limited to 200 mg / day in individuals with diabetes (level of evidence B).
- The use of fish rich in omega-3 fatty acids (tuna, sardines, mackerel and salmon, among others) is recommended two or more times a week, especially in those with hypertriglyceridemia (level of evidence B).
- Monounsaturated fatty acids, found in olive oil, avocado and some oilseeds, have been studied for their beneficial effects on blood lipids (level of evidence B). Likewise, the consumption of approximately 2mg /day of plant sterols blocks the intestinal absorption of cholesterol with the consequent decrease in circulating total cholesterol and LDL-C.

(b) Carbohydrates

- A healthy dietary pattern is recommended whose carbohydrates come from fruits, vegetables, grains, and skim milk (level of evidence B).
- The estimation of the total carbohydrate content of the diet is the main strategy in glycemic control, therefore its monitoring, whether by counting carbohydrates, exchanges or calculating portions based on experience, is the key in nutritional therapy (level of evidence A).
- The recommended contribution is 45-65% of the total caloric value, despite constituting the largest contributor to postprandial blood glucose concentration. In addition, they are a source of energy, water-soluble vitamins, minerals and fiber. An intake < 130g/ day is not recommended due to the absolute requirement of glucose by the brain and central nervous system.
- Both the total amount and the type of carbohydrate in the food (quality) influence the blood glucose level. However, the use of the glycemic index (GI) and glycemic load (GL) is considered to provide a moderate additional benefit on glycemic control than when only total carbohydrates are considered (level of evidence B).
- A dietary fiber intake of 14 grams per thousand calories is recommended from cereals, fruits and vegetables, preferably not modified in their physical form (level of evidence A).

(c) Proteins

- For individuals with diabetes and normal renal function, a protein consumption between 15 to 20% of the total caloric value is suggested (level of evidence E).
- In subjects with type T2DM, the consumption of protein can increase the insulin response without increasing the concentration of circulating glucose. Therefore, proteins should not be used to treat or prevent nocturnal hypoglycemia (level of evidence A).
- The long-term effect of high protein diets (> 20% of total calories) on kidney function is not known, therefore they should only be used for short periods in individuals with normal kidney function (level of evidence E).

(d) Sweeteners, alcohol and micronutrients

- The consumption of non-nutritive sweeteners such as acesulfame potassium, aspartame, neotame, saccharin and sucralose has been approved by the Food and Drug Administration as long as they are within the recommended amounts (level of evidence A). Mannitol, xylitol and sorbitol type sugar alcohols are characterized by their osmotic effect and provide 2 kilocalories per gram, so when used they must be counted within the total amount of carbohydrates in the diet (level of evidence A). As for fructose, although it produces a lower postprandial glycemic response in relation to sucrose and starch, it should be limited to that naturally contained in fruits, which is equivalent to 3 to 4% of the total energy. It is not recommended for use as a sweetener in carbohydrate and lipid metabolism disorders.
- In adults with DM who wish to consume alcohol, their consumption should be restricted to one drink / day or less for women and 2 drinks / day or less for men (level of evidence B).
- Routine supplementation with antioxidants, such as vitamin E, C and β-carotene is not recommended due to the lack of evidence of their efficacy, as well as the effect of their long-term use. The benefit of chromium supplementation in people with DM or obesity has not been conclusively demonstrated, therefore it is not recommended.

(e) Other nutrients

- It is recommended to limit salt intake to less than 5 grams per day or 1,000 mg of sodium per 1,000 calories, with a greater restriction being possible in cases of hypertension or symptomatic heart disease (level of evidence A).
- Bariatric surgery should be considered in adults with T2DM and BMI $\geq$ 35 kg / m^2, difficult to control despite compliance with treatment (level of evidence B).
- T2DM patients with bariatric surgery warrant monitoring of their drug treatment (level of evidence E).
- There is insufficient supportable evidence to indicate surgery to achieve glycemic control in patients with T2DM and a BMI of 30 – 35kg / m^2 (level of evidence E).

- The long-term benefits, cost-effectiveness and risks of bariatric surgery in individuals with T2DM should be studied in well-designed randomized protocols and compared with a well-controlled group of lifestyle and drugs (level of evidence E).
- Gastric reduction either by gastric band or procedures involving bypass or transposition of the small intestine, forming part of a multifactorial therapeutic plan, can be an effective strategy for weight loss in patients with T2DM and severe obesity with BMI ≥35 kg /m^2.

2.8 Olive Oil and Health

Olive oil is obtained from the fruit of the olive tree (*Olea europaea*), which is widely grown especially in the Mediterranean basin and neighboring regions, and the first information goes back to Roman and Greek mythology. This vegetable oil is the main source of dietary oil, which is often known as the "Mediterranean diet" in countries surrounding the Mediterranean where olives are grown and responsible for the low incidence of chronic degenerative disease (Harshitha *et al.* 2016).

Olive oil (olivea oleum) is a transparent, greenish / yellowish and aromatic liquid obtained by squeezing it together with the olive core and without any chemical treatment. International olive oil council, olive oil; It classifies it as extra virgin olive oil, refined olive oil, olive oil, and pomace (olive-pomace) olive oil. Extra virgin olive oil is obtained from the fruit of the olive tree by mechanical and physical means (cold pressing technique) only, which does not cause any change in the oil content. Extra virgin olive oil is not subjected to any process other than washing, decantation (separation from sediment), centrifugation and filtration. Extra virgin olive oil, according to the degree of acidity; Extra virgin olive oil, virgin olive oil and natural (natural) olive oil (maximum free acidity, 1.0g, 2.0g, and 3.3 g/ 100g, respectively). It is suggested that if the acidity of extra virgin olive oil exceeds 3.0, the main phenolic compounds in the oil and to a lesser extent components such as squalene are lost (Harwood and Yaqoob 2002).

When extra virgin olive oil is compared with other olive oils; it is considered to be a unique dietary oil in terms of holding compounds with phenolic structures, most of which

are polar minor components, protecting fruit in response to environmental stress. Various factors, for example; variety, geographical region, agricultural techniques, climatic conditions, fruit ripeness, fruit storage, processing and oil storage methods and so on. Conditions affect the olive oil flavour. The main (major) components of olive oil are fatty acids, totalin; 55-83% of MFA; especially oleic acid consists of 4-20% PUFA and 8-14% saturated fatty acids. Although olive oil contains high levels of MFA, it also has other minor components with very important biological properties.

2.9 Minor Components That Make up 1-2% and are Divided into Two Classes

i. The non-saponifiable fraction (which can be removed with solvents after saponification of the oil); While it contains squalene and other triterpenes, sterols, tocopherol and pigments.
ii. Soluble fraction; Contains phenolic compounds. Although the minor components are about 2% of the total oil weight, it contains more than 230 chemical compounds.

It is known that olive oil, which is considered as a functional food with its different components that can contribute to its general therapeutic properties, is an important source for phytochemicals such as polyphenolic compounds, squalene and alpha-tocopherol, as well as a high rate of MFA.

2.10 Olive Oil Major Components Oleic Acid

Major components of olive oil are also known as saponifiable/ glyceride fraction, and triacylglycerols constitute approximately 98% of total oil weight. While oleic acid constitutes 70 - 80% of the fatty acids in olive oil, the minor components are approximately 2%. Minor ingredients are mostly present in extra virgin olive oil, as the refining process causes the loss of these compounds. Its positive effects on health are generally related to its high content of MFA (oleic acid). Recommended fatty acid contents for olive oil according to international standards (extra virgin and refined); 56 - 83% oleic, 7.5 - 20% palmitic, 3.5 - 20% linoleic, 0.5 - 3.5%, stearic, 0.3 - 0.5%

palmitoleic, 0 - 1.5% linolenic, 0 - 0.5% myristic acid and much less other oil It should consist of acids (Gavahian *et al.* 2019).

In olive oil, the rates of monounsaturated, polyunsaturated and saturated fatty acids are on average 73%, 11% and 14%, respectively. Since olive oil is the main source of fat intake, the rate of MFA (oleic acid) is high and saturated fatty acids are low in the Mediterranean diet. Since oleic acid, which has a single unsaturated bond, is less susceptible to oxidation, its high content contributes to the antioxidant effect, high stability, and long shelf life of olive oil. The antioxidant activities of oleic acid and phenolic compounds in olive oil have been shown in both experimental and human studies. As the consumption of Monounsaturated Fatty Acids (MFA) (oleic and linoleic acids) is associated with a decrease in plasma LDL levels and an increase in HDL levels, it has been shown that oleate-rich LDL is less prone to oxidation than linoleic-rich LDL. It has been reported that dietary oleic acid content decreases oxidized LDL, LDL cholesterol and TG levels without a decrease in HDL. Medina and his team in 2013 pointed out the importance of saponification and non-saponification fractions in extra virgin olive oil against lipid peroxidation in rabbit heart mitochondria, Sameh and his team in 2018 also reported that oleic acid is not only responsible for the antioxidant effect of olive oil against atheroma plaque formation. The Mediterranean diet and MFA abundant olive oil also play a role in the primary prevention of "non-alcoholic fatty liver" (NASH) disease. Although some in vitro and in vivo studies examining the effect of oleic acid on cancer have been reported to play a role in cancer prevention, this may be due to the secondary effect of fatty acids (preventing oxidative stress) or direct anticancer effect on fat stability.

2.10.1 Olive oil minor components

Squalene: Squalene is a triterpene hydrocarbon often found in nature and is an important intermediate product in cholesterol biosynthesis. It is found in very different amounts in both plants and animals. The high squalene content in olive oil (430mg / kg; 0.2-0.7%) is thought to be a major factor in the cancer risk-reducing effect of olive oil compared to other foods (< 0.03% in other oils). Despite its widespread distribution throughout the

body, squalene is found in high levels (12%) in sebum and lower (<0.04%) levels in adipose tissue, since most of it penetrates the skin. Due to its structure, squalene probably scavenges singlet oxygen species rather than hydroxyl radicals, and high level of UV radiation exposure causes carcinogenic singlet oxygen formation in the skin where high squalene concentration can provide a chemoprotective effect (de Medina *et al.* 2013). Squalene, which is present in high amounts in the Mediterranean diet, is believed to be responsible for the low incidence of skin cancer in epidemiological studies conducted in populations consuming this diet. Animal studies have shown that topical squalene has an inhibitory effect on chemically induced skin carcinomas. The addition of squalene to the diet in rats resulted in an 80% increase in serum squalene levels and hepatic HMG-CoA reductase inhibition; it has been reported that the tumor inhibitory role suggested for squalene in in vitro experiments and animal models arises from HMG-CoA reductase inhibition. Dietary squalene, which is thought to suppress the aberrant crypt foci induced by azoxymethane in colonic mucosal cells by HMG-CoA reductase inhibition, as an alternative; It is also possible to modulate bile acid biosynthesis induced by tumor promotion. HMG-CoA reductase inhibition also reduces the signal transducer function of the "ras oncogene", which resides in cell membranes, hence farnesyl pyrophosphate, which is required for prenylation. HMG-CoA reductase inhibition by squalene is also among the protective mechanisms against fatty liver formation.

Alpha-tocopherol: The basic form of vitamin E found in olive oil is α-tocopherol, which constitutes approximately 95% of total tocopherols (the remaining 5% beta and gamma tocopherols). The total tocopherol content in extra virgin olive oil is in the range of approximately 200mg / kg (0.2%) or 98 - 370mg /kg. Although high levels of PUFA are required for absorption of vitamin E in the body, the levels of PUFA in olive oil are low. The main antioxidants in olive oil are carotenoids and polyphenolic compounds, and primary polyphenols are oleuropein, hydroxytyrosol and α-tocopherol. In contrast to lipophilic compounds (tocopherols), it has been reported that hydrophilic (phenolic) compounds show high correlation with oxidative stability in extra virgin olive oil. A-tocopherol known as the active form of Vitamin E is highly resistant to oxidative degradation. Despite its presence in relatively low concentrations in olive oil, daily consumption protects cells against free radicals and lipid peroxidation by increasing the

entire antioxidant content in the human body. In addition, it is known that exogenous antioxidants contribute to the protection against degenerative diseases by increasing the level of antioxidants available in the body.

Phenolic Compounds: Hydroxytyrosole: There are also many phenol compounds in olive oil that have important health benefits. It has been reported that the total phenolic content in olive oil, which is the source of more than 30 phenolic compounds, is around 196-500 mg per kg, and this amount varies between 40 - 1000 mg / kg in some sources, it has been shown that the methods used are different, causing inconsistency between the amounts observed in different publications. (Tripoli *et al.* 2005) reported a wide range for Italian olive oils (50 - 1000 mg / kg), the total phenolic compound value in extra virgin olive oil was reported to be 232 ± 15 mg / kg. Phenol concentration, like olive oil flavor; it depends on a number of factors including environmental growth conditions, oil production method and storage conditions. Lignans are the most common phenolic compounds in olive oil, followed by simple phenols (hydroxytyrosol and tyrosol) and secoiridoids (oleuropein, ligstroside aglycon and decarboxylated dialdehyde derivatives of each of these) originating from oleuropein. Each phenolic compound in olive oil inhibits auto-oxidation, and simple phenols, secoiridoids and lignans constitute 47% of total phenols in extra virgin olive oil (Afify *et al.* 2018).

Oleuropein: Oleuropein is a compound belonging to secoiridoids abundant in Oleaceae, a specific group of coumarin-like compounds. Secoiridoids, which are found only in plants such as olive trees and produced from the secondary metabolism of terpenes, are characterized by the presence of glucosidic or aglyconic forms of elenoic acid in their molecular structure. While oleuropein is the ester of elenolic acid and dihydroxyphenylethanol, 3.4-DHPEA, commonly known as hydroxytyrosol, is the major degradation product of oleuropein, in other words, the precursor to oleuropein. Hydroxytyrosole acetate is another derivative of hydroxytyrosol, and verbascoside is a conjugated glucoside of hydroxytyrosol and caffeic acid. The most abundant phenolic compound oleuropein in olive fruit constitutes 14% of the dry weight. During the maturation phase, oleuropein undergoes enzymatic and non-enzymatic hydrolysis to form simple phenolic compounds such as hydroxytyrosole in extra virgin olive oil. The amount

of hydroxytyrosol in olive oil, which is found in the leaves as well as olive fruit and together with other phenolic compounds such as oleuropein, ranges between 113.7 - 381.2 mg / kg. Since it has a higher polyphenol content than olive oil, it has been observed that interest in alperujo (pomace) and olive black water (formed in the process of obtaining oil), especially olive leaves, has increased recently (Fito *et al.* 2007).

2.11 Biological Effects of Antioxidants in Olive Oil

In addition to exposure to external sources due to different reasons, ROT, which is continuously produced as a result of metabolism in the human body, is controlled by antioxidants, especially endogenous enzymes. When these reactive species are overproduced as a result of exposure to external oxidant agents or a deficiency in defines mechanisms, they can cause damage to many biomolecules (DNA, proteins, lipids). Damage due to oxidative stress is thought to be associated with an increased risk of cardiovascular diseases, cancer, and some chronic diseases (Mazzocchi *et al.* 2019). In recent years, many epidemiological studies have drawn attention to the inverse relationship between mortality rates in chronic diseases and the intake of vegetables and fruits containing antioxidants, especially in Mediterranean countries. Attention is drawn to the role of especially antioxidant content of olive oil, which is an important component of the Mediterranean diet. Of the three main phenolic compounds in olive oil, hydroxytyrosol and oleuropein, unlike tyrosol, it has a catechol (2-hydroxyphenol) structure, and it is known that compounds with catechol group show antioxidant activity. These orthodiphenol or catecholic groups stabilize free radicals by forming intermolecular hydrogen bonds. Both phenol compounds, which scavenge free radicals and are considered powerful antioxidants, inhibit LDL oxidation and show dose-dependent activity in the micro-mole range. Its antioxidant activity has been shown to scavenge and scavenge various oxidants and free radicals such as hydroxytyrosol and oleuropein, hydrogen peroxide, hypochlorous acid and superoxide, with endogenous vitamin E and antioxidants such as exogenous DMSO and BHT. It has been suggested that hydroxytyrosol, which is more hydrophilic than oleuropein, acts as a scavenger of aqueous peroxyl radicals near the membrane surface, and oleuropein acts as a scavenger of lipid peroxyl radicals extending the chain in the membrane. Studies have shown that

hydroxytyrosole can prevent hydrogen peroxide-induced cytotoxicity as a lipid peroxidation chain-breaking inhibitor and by binding iron ions. Since it has a strong chelating effect on metals such as iron, hydroxytyrosole has also been reported to reduce the ROS formation derived from related reactions. It was first reported by Chalasani and his team in 2004 (Chalasani *et al.* 2004). That low isoprostane and TBARS levels in LDL lipoproteins are due to the protective effects of this antioxidant compound from peroxidation of LDL lipoproteins, and later similar in vitro and experimental study results confirmed these effects of hydroxytyrosol. Another study (Harshitha *et al.* 2016) showed that olive phenols and their metabolites are more effective inhibitors of lipid and protein oxidation compared to vitamin C and E. Olive oil, in particular, has been shown to form membranes that are more resistant to lipid peoxidation and to be more functional compared to those formed with polyunsaturated oils such as sunflower oil. (Ninfali *et al.* 2001) reported that olive oil has higher antioxidant capacity (OH radical scavenging power) than other vegetable oils, and that the ratio of antioxidant compounds is higher in extra virgin olive oil than in refined extra virgin olive oil. The polyphenols found in olive oil, such as oleuropein, hydroxytyrosol, tyrosol and caffeic acid, have significant antioxidant and anti-inflammatory effects.

Oleocantal; It is another organic (tyrosol ester) compound isolated from extra virgin olive oil and associated with oleuropein. It has been reported that oleocantal, which also has antioxidant properties, has an anti-inflammatory effect similar to ibuprofen interestingly. Long-term consumption of small quantities of oleocantal in olive oil may be partly responsible for the lower incidence of heart disease associated with the Mediterranean diet; It is suggested that an average of 50 g of olive oil per day has a similar effect to 1/10 adult ibuprofen dose. Some carotenoids, which are among the minor components of olive oil, also have antioxidant effects, and the predominant carotenoids are beta-carotene and lycopene, which are also responsible for the color of olive oil. It has been reported that beta-carotene levels in the range of 0.33 - 3.69mg / kg in extra virgin olive oil obtained from ripe olives can reach 10 mg levels depending on some factors (Foscolou *et al.* 2018).

2.12 Olive Oil and Therapeutic Use Potential

In recent years, the importance of dietary olive oil in many diseases including chronic diseases and cancer has been emphasized in the literature. Especially protective against cardiovascular diseases, hypertension and hemostatic components (platelet function, thrombogenesis and fibrinolysis) has been reported to have regulatory and anti-inflammatory effects. Modern medicine could only realize the positive effects of olive oil, which first attracted the attention. Studies conducted in the last 20 years show that olive oil consumption is associated with a reduction in the risk of cardiovascular heart diseases, obesity, metabolic syndrome, type 2 diabetes and hypertension. A strong inverse correlation between olive oil consumption and a first non-fatal myocardial infarction was reported in a case-control study. The results of another case-control study and a large cohort study also showed similar inverse relationships. In another study, although no relationship was found between olive oil consumption and the incidence of type 2 diabetes, it is thought that this may be due to the olive oil type. The diet rich in extra virgin olive oil, which is one of the mechanisms related to cardiovascular risk factors and atherogenesis; It has been shown that while decreasing TG and LDL levels, it increases HDL cholesterol levels, increases the resistance of LDL to oxidation, and regulates glucose metabolism in diabetes. It has been reported that polyphenol components (hydroxytyrosol and oleuropein) in extra virgin olive oil, which are powerful scavengers of superoxide radicals, inhibit LDL oxidation, as well as modify the content of LDL cholesterol. While the risk of developing obesity in 6 years was 2.3 times higher in those who consumed sunflower oil as cooking oil than those who consumed olive oil, in another study on obese women with insulin resistance; It has been reported that meals cooked in extra virgin olive oil significantly reduced both insulin resistance and C-peptide levels (Mansour 2012, Mansour *et al.* 2014).

Increasing data on the Mediterranean diet and its integral part of olive oil suggest that it may have a potential role in reducing the risk of some types of cancer. Although its anti-cancer effects are not known precisely, it is possible that phenolic compounds, especially in olive oil, can reduce cancer risk because of their potential to inhibit carcinogenesis at various stages; it has been reported that polyphenols such as hydroxytyrosol and

oleuropein can stimulate anti-proliferative and pro-apoptotic effects in colorectal cancer cell types. The results of a large study showed that olive oil consumption was inversely associated with the risk of developing breast and digestive system cancer, and the results of another study conducted in the Canary Islands also showed a protective effect against breast cancer. In addition to oleic acid found in extra virgin olive oil, the role of minor bioactive components such as squalene and phenolic antioxidants is highlighted in low cancer development risk. While it is estimated that there is an annual consumption of olive oil of up to 15 kg per person in Mediterranean countries, it has been suggested that the protective effect of olive oil at a daily consumption of 30.5 g in women in terms of breast cancer is the highest. Thanks to the many chemical and antioxidant phenolic compounds it contains, olive oil, which has the potential to be a functional food, has shown that different types and components such as extra virgin and extra virgin olive oil are beneficial, preventive and / or therapeutic. It seems to concentrate on its effects (Gorzynik-Debicka *et al.* 2018).

As olive oil is widely used in the traditional treatment of many diseases in various countries, although it contains higher fat than other western diets, there is important evidence that there is a relationship between the Mediterranean diet and the decrease in the incidence of cardiovascular diseases and some types of cancer. An important component of this diet is Monounsaturated fatty acids; Olive oil rich in oleic acid. Results from both epidemiological and animal studies support the idea that olive oil has potential beneficial effects for certain diseases such as hypertension, cardiovascular diseases, diabetes, hyperlipidemia and cancer. These beneficial effects are mostly due to the phenolic components of olive oil with antioxidant properties, especially oleuropein and hydroxytyrosol. These polyphenols have antiviral, antibacterial, anti-inflammatory and anti-carcinogenic effects besides their antioxidant properties. Further and detailed research is needed on the underlying molecular mechanisms, especially at the cellular level, on the therapeutic efficacy of olive oil and its bioactive components, as well as broader clinical studies on olive oil varieties and ingredients.

2.13 Olives and Olive Oil Can Be Great Allies Against Diabetes

Because of their anti-inflammatory and antioxidant properties, olives and olive oil help fight and prevent bad cholesterol, obesity, cell aging and cardiovascular disease. In addition, they can be great allies against diabetes. For diabetics, a diet rich in olive oil (especially extra virgin), moderate in carbohydrates and low in saturated fats can be an active ally against the disease. He explains that olives and olive oil help to reduce low-density lipoproteins by controlling the blood sugar level. In addition, they have improved insulin sensitivity, causing the hormone produced by the pancreas to help glucose enter cells (Yubero-Serrano *et al.* 2019).

Check out the different types of olive oil below:

- Extra virgin: It is the purest olive oil and the best to consume. It has a mild flavor. With just one press, it contains 1% acidity and is suitable for daily use.
- Virgo: By going through two or three presses, it contains 2% acidity and is indicated for cooking processes on fire.
- Refined: It is the most suitable for frying, as it undergoes deodorization, neutralization and discoloration.
- Pure: It is the least concentrated, as it is a mixture of refined and virgin olive oils.

In the majority of diagnosed cases of type 2 diabetes, treatment consists of a lifestyle change. First, controlling the consumption of hypercaloric foods and sugars, secondly, increasing physical activity.

Recent evidence supports that following a Mediterranean Diet reduces the risk of people developing type 2 diabetes and, in the case of patients who already have this disease, such a diet improves glycemic control and offers cardiovascular protection. You can learn more about the Mediterranean Diet in previous posts where we talked about the foods that make it up.

It has been widely demonstrated over many years the benefits that a balanced diet with the presence of the virgin exra produces on those who suffer from this disease. Specifically, the daily consumption of raw extra virgin olive oil reduces vascular problems derived from diabetes.

In addition, it has been found that the effects of the oil directly affect the glucose levels of patients, reducing blood levels, in the same way as the levels of LDL cholesterol, commonly called bad cholesterol.

2.13.1 Extra virgin olive oil (EVOO) improves diabetes

Of the fatty acids present in EVOO, there are two fundamental ones: oleic acid and linoleic acid, it is illustrated in Figure 2.1, but in the most recent studies, hydroxytyrosol, a small but powerful polyphenol responsible for the antioxidant action of olives, has gained special importance (Foscolou *et al.* 2018). A study from the University of Malaga has shown that the continued consumption of hydroxytyrosol in small amounts helps to reduce vascular inflammation associated with diabetes mellitus. Another study published in the journal Medicines associates this compound with several beneficial effects as an antioxidant, anti-inflammatory, anticancer and skin protector.

How to prevent type 2 diabetes

- Having a healthy lifestyle can prevent or delay the development of this diabetes. Next, we leave you a series of useful tips.
- Eat fruits and vegetables at every meal.
- Balancing protein sources.
- Avoid excessive consumption of saturated fat.
- Cut down on carbohydrates and avoid sugary drinks.
- Eliminate tobacco and avoid alcohol.
- Do physical activity daily.
- Carry out regular health checks.

Figure 2.1 Olive oil

2.13.2 Olive oil in the treatment of diabetes mellitus (DM)

Scientists from the University of Malaga integrated in the Biomedical Research Institute of the Andalusian city (IBIMA), in collaboration with experts from the Institute of Fat (CSIC), have shown that the daily consumption of hydroxytyrosol, a polyphenol present in the oil of extra virgin olive, reduces or could even prevent vascular problems derived from diabetes mellitus. The research has been carried out with rats that had been inoculated with this disease. The study, published in the Journal of Nutritional Biochemistry, has proven for the first time that continuous intake of hydroxytyrosol in low doses, 0.5 to 2.5 milligrams, is sufficient to reduce vascular inflammation associated with the disease (Gaforio *et al.* 2019).

The recommended intake of hydroxytyrosol would be about 3 tablespoons of crude Extra Virgin Olive Oil, which coincides with the recommended daily amount for this food. The key is to consume this amount from the time the disease is diagnosed to help stop its progression, even if we do not suffer from any type of disease, this daily intake will have numerous benefits for our health (Shehab *et al.* 2018).

As angela A rivellese, professor of applied dietetic sciences of the department of clinical medicine and surgery of the federico II university, has highlighted to Mercacei, extra virgin olive oil is the basic axis of the Mediterranean diet and has already shown to be beneficial for others cardiovascular disease, blood pressure or fatty liver.

The researcher has specified that this finding comes from the scientific rigor provided by new technologies together with the randomized controlled design. Thus, the tests were carried out in the patients' homes using integrated insulin pump systems and continuous glucose monitoring, which allowed immediate translation of the clinical data for the preparation of the study.

People who require treatment can opt for natural products, such as olive oil, which is hypoglycemic and beneficial for its other health properties: it is hypocholesterolemic and hypotriglyceridemic, among others. The objective of this research work is to investigate the efficacy of olive oil extracted from the olive tree (*Olea europaea*) in patients with type 2 diabetes, in the reduction of glucose levels, choosing for this purpose residents of Iraqi people attended Teaching Hospital, Basrah medical College, University of Basrah, Iraq during 2019 to 2020.

2.14 Problem Statement

Diabetes is one of the most critical problems that occurs today in our population, and it brings serious health problems. That is why the following question was raised. Does the administration of olive oil produce a decrease in glucose levels in diabetic people of Iraq.

2.15 Hypothesis

To characterize patients with type II Diabetes Mellitus patients reported in Teaching Hospital, Basrah, Iraq during January 2019-March 2020 and Treatment with olive oil is capable of lowering glucose levels in patients with type 2 diabetes.

2.16 Objectives General Objective

- Analyse socio-demographic aspects and lifestyle habits.
- Check for the presence of other pathologies associated with diabetes.
- Identify which drugs are most used by patients.
- Identify possible non-adherence to drug treatment.
- To investigate the efficacy of Olive oil (Olea europaea) in patients with type 2 diabetes.
- Determine the blood glucose levels in the selected population.
- Identify people with hyperglycemia.
- Determine glucose values in people with type 2 diabetes after treatment with olive oil.
- Determine in a control group without treatment with olive oil at baseline in a determined time of 3 months.

2.17 Variables

Dependent: decrease in glucose levels. Independent: treatment with olive oil.

2.18 Justification

Our ancestors of the Basrah governorate, for many years, have treated diseases with medicinal plants. Among them, type 2 diabetes. Therefore, this research work will demonstrate the efficacy of Olive Oil in lowering glucose levels in a population of people with hyperglycaemia.

2.19 Diabetes Mellitus in Iraq

The overall population of almost 6.7 per cent (~421 million people), with nearly 200 million females at 1 July 2015, in 20 Middle East and North countries. T2DM prevalence increased dramatically between 1980 and 2014 in adults aged 18 years, 2.3 times across Eastern Mediterranean and African regions. This sharp rise is higher in these two regions than in the Americas (1.7 times), the Western Pacific (1.9 times) and the European (1.4

times) regions. From January 2009 to January 2018, data from 9,331 patients with DM obtained at two locations in North Iraq have been studied retrospectively. The majority of cases were from the Ibn Sena teaching hospital Basrah diabetes center in Basrah city, and a smaller number were from outpatient clinics.

Governorate of Mosul in Nineveh and distributed cases from private hospitals. The Basrah Diabetes Center is a well-known centre in Northern Iraq for diabetic patients who provide all required ambulatory services in the region. Those that need tertiary treatment in the hospital are sent directly to the hospital's medical facilities. 3471 were males, with 5860 being females out of 9331 patients. The remaining 627 (6.7%) patients were for T1D. The contribution from T2D was 8704 (93.3%) (Mansour 2015).

In a village named Al-braja, in Shatt al-Arab district, Basrah, south Irak, the oldest research was carried out on diabetes mellitus in Iraq since 1978. They used oral glucose tolerance for a diagnosis of diabetes. In both 2 hours glucose of 120 mg/dL or above was diagnosed with the glucose load of 50g and with diabetes. The research was confined to the small sample (228 individuals), with registration of children aged 15 and most suspected new diabetes having classical diabetes symptoms (e.g., polyuria, polydipsia, weight loss). However, the report shows that 5 percent of diabetes is prevalent in the study population. In the Basrah centre were 5,445 people aged 19-94 years in all of Basrah and the HbA1c measured in 88.3% of population, while the FPG measured in 18.7%. A trial was performed between January 2011 and October 2012. Around 8.7% had been diagnosed with diabetes already, while the age adjusted for diabetes, 19.7% had been diagnosed by screening and 11% had previously not been diagnosed with diabetes. In addition, the prevalence of dysglycemia was 48.8 per cent, with just 29.1 per cent of screened populations having prediabetes 51.2% of screened individuals had normaloglycemia. Diabetes prevalence peaked at 46-60 years of age in both sexes. In this study, one in five subjects had diabetes in Basrah in southern Iraq. Iraq faces a diabetes mellitus epidemic such as the Middle East epidemic. To deal with this problem, medications for diabetes and insulin should be available, healthcare systems should deal with this epidemic. In order to assess the epidemiology of the disease, increasing studies are required (Mansour *et al.* 2008).

In > 93% of the population in the sample, T2D was diagnosed. This statement reflects the 2013 WHO Diabetes report. In early ages, T2D was once thought to be an adult disorder and became gradually recognised. Although the bulk of newly admitted T2D patients in the current study is between 40-60 years, almost a quarter of them fell below 40 years and are mostly age clustered (30-39). The US National Diabetes Statistics for 2011 showed that T2D is higher in new cases for Asian/ Pacific Americans and Indian youth aged 10-19 years than for T1D. It is worth noting that the current inception statistic for T2D in patients under 40 years of age was higher than for T1D (77% vs. 23%). But the outcome of that ratio between DM types would probably change if the comparison was above done in patients under 30 or 20 years, provided that more T1D patients fall into this category. In addition, the majority of T2D patients were obese or overweight, including those under 40 years of age and body weight as well as body weight index, were considerably higher in younger T2D age groups, especially those in 20-40 years of age. There have been no such differences in body weight and BMI among T2D age groups above or below 40, other than the ages of 0–19, just for less than 1 percent of T2D's total.

Around 63% of T2D patients were aged 40-59 years in this study, the fact is that main messages in Diabetic Atlantic IDF in 2014 were communicated. While T2D patients gradually gained more than 12 percent in older age groups but new T2D begins in the ages older than 60 years of the current sample. In comparison, some research find that T2D in older age groups is more frequently present. The results undoubtedly reflect an increased prevalence and seriousness of obesity, which were also correlated with Iraqi society in the younger ages study as a result of food, lifestyle changes and urbanisation (Schwingshackl *et al.* 2017).

2.20 Role of Olive Plant in DM Treatment

The antiseptic properties of olive leaves are very effective against harmful bacteria, viruses, fungi and parasites. Olive leaf balances the circulatory system and hypertension thanks to the ingredients it contains. This plant, which is a mild diuretic, is a good immunostimulant in diseases that occur in immune system deficiencies such as colds and flu. In various studies conducted so far, they found that olive leaves have low levels of

saturated fatty acids, whereas high levels of monounsaturated fatty acids (Wainstein *et al.* 2012).

In studies conducted to date, they have determined the effect of olive oil on reducing the risk of breast cancer, which is frequently seen in diabetes patients, by keeping the hyperglycemia disease accompanying diabetes under control. They found that olive leaf, which is used to eliminate blood circulation anomalies frequently seen in diabetics, acts by accelerating blood flow, the first of the two main mechanisms of the hypoglycemic activity of olive leaf is the enhancement of glucose-induced insulin secretion, and the second is achieved by increasing peripheral glucose intake.

The phenolic compounds in olive leaves have both antioxidant and anti-inflammatory properties. In addition to the main substance group, secoiridoids (oluropin and its derivatives), the hydroxytyrosol, polyphenols (verbascoside, apigenin-7-glucoside, and luteolin-7-glucoside), triterpenes containing oleanolic acid, and flavonoids such as rutin and diosmin have these properties (Eldeeb *et al.* 2015).

2.21 Mechanism of Action

They determined that olive leaf has numerous compounds other than oluropin and flavonoids such as rutin, apigenin, luteolin, chrysoeriol, hesperidin, rutin, quercetin, and campherol. Oluropin, the substance found at the highest level in olive leaves, constitutes approximately 20% of the total substances. Studies have found that this substance inhibits insulin release in cells exposed to hydrogen peroxide (Rupeshkumar *et al.* 2014).
Olive leaf extract has been extensively studied in humans. In another *in-vitro* study; they ensured that Jurkat cells in the culture medium continuously produce hydrogen peroxide. But in extracts above 100-mcg / mL level. They found that although there was no hydrogen peroxide produced by it in the environment, the DNA destructive effect of the extract appeared. As a result of the study, they determined that the extracts of olive leaves, far from the restorative and therapeutic effect, can perform DNA damage alone (Gürbüz and Öğüt 2020). In the applications about the effects of hydroxytyrosol and oluropin in olive leaves on rats, they found that blood sugar and cholesterol lowering effects. In these

experiments, they also stated that it reduces the side effects of diabetes by suppressing oxidative stress. They found that in diabetic rats fed olive leaves, insulin secretion increased, serum glucose level decreased, and antiglycemic index was high.

In another study, researchers demonstrated the hypoglycemic and hypolipidemic activity of the plant by oral administration of olive leaves to rats (Park *et al.* 2013). They found that the oluropin substance was administered to rabbits to reduce oxidative stress. In some other studies, they determined the antioxidant activities of oluropin and hydroxytyrosol substances. In a study conducted on olive leaf, they proved that there was a statistically significant decrease in serum glucose and cholesterol levels in diabetic rats and that olive leaf extract exhibited antioxidant effect 4 weeks after its use (Ghanema and Sadek 2012).

Oluropin has been reported as an effective hypoglycemic agent in diabetic animals. They showed that oluropin, the most abundant active phenolic compound in olive leaf extract, reduced blood glucose, plasma malondialdehyde (MDA) and other markers of oxidative stress in the alloxane-induced diabetic rabbit model. They found that oluropeocyte exhibited antidiabetic activity in animals with alloxan-induced diabetes, and that the hypoglycemic activity of this compound was associated with the auto-antibody of glucose-induced insulin release and increased glucose peripheral uptake (Ghanema and Sadek 2012). (Wainstein *et al.* 2012) applied olive leaf to 79 patients with type 2 diabetes for 14 weeks and found that it significantly reduced blood glucose levels (HbA1c) and fasting insulin levels. Showing the vasodilator properties of olive leaf, Grenada University researchers also reported that it has positive effects on the blood sugar levels of animals. They found that in rats with alloxane-induced diabetes, 16 and 32 mg/ kg doses significantly decreased blood glucose levels and increased peripheral glucose uptake in a dose-dependent. In addition, they also showed that luteolin and oleanolic acid components have an inhibitory effect on postprandial glucose increase in diabetic rats. The studies mentioned so far have revealed that the hypoglycemic activity of olive leaf reduces blood sugar or blood sugar levels by working independently of insulin to increase the metabolic uptake of glucose in diabetics. Although it is seen that the extract acts as a trigger of DNA damage due to overdose, they stated that when used in appropriate doses, olive leaf extract is also effective, but the raw form of the leaf is more effective.

Studies have shown that the compounds of natural olive leaves reduce blood sugar levels. After brewing the dried leaves, it is recommended for diabetics. Olive leaf used in this way is effective in the treatment of various complex diseases including diabetes, cardiovascular disorders, viral and microbial infections; however, they emphasized the need for studies to evaluate evidence for other traditional uses of the herb.

Since individuals with type 2 diabetes often suffer from these conditions as part of the 'Metabolic Syndrome' (combination of cardiovascular disease and diabetes), the use of olive leaves to regulate blood sugar is not only important in the treatment, but also in the treatment of hypertension and hypercholesterolemia. The literature (Maurya *et al.* 2019) has shown that most of the compounds found in olive leaves have antioxidant properties, preventing or reducing the harmful effects associated with diabetes. It has shown that olive leaf and extract are associated with the improvement of glucose homeostasis in humans and can be facilitated by reducing starch digestion and absorption in animal experiments.

3. MATERIALS AND METHODS

3.1 Materials

3.1.1 Methodological approach

To carry out this study, a quantitative methodological approach was chosen. According to (Mohamed *et al.* 2021) quantitative studies "consist of empirical investigations whose main purpose is to outline or analyse the characteristics of facts or phenomena". They are more suitable for planning collective actions due to their greater precision and reliability.

3.1.2 Nature of study

This study is characterized as a descriptive research, that is, “which aim to describe the characteristics of a given population, in addition to identifying possible relationships between variables”. As for technical procedures, the survey method was used, which in Gil's opinion characterized by the direct interrogation of people whose behavior one wants to know. Basically, a significant group of people is asked to provide information about the problem studied, and then, through quantitative analysis, to obtain the conclusions corresponding to the data collected.

3.1.3 Research location

The study was carried out in the Teaching Hospital, Basrah University, and Basrah, Iraq. In this location there is a Basic Health Unit, which served as a reference for the selection of the studied population.

3.1.4 Characterization of the population

The subjects of this study were people with type II Diabetes Mellitus users of the Basic Health Unit in the Teaching Hospital, Basrah University. The selection of participants

was carried out from the records of diabetic patients obtained from the teams of the Family Health Program (FHP). Initially, contact was made with the head nurse and with the community health agents with the objective of presenting the project, knowing the number of diabetic patients registered in the FHP and obtaining the names and addresses of all individuals assisted in the different micro areas that make up the region served by Teaching Hospital, Basrah University. Among the 150 registered patients, 120 participated in the research.

The inclusion criteria for participation in this research were: individuals over 18 years of age, registered with the FHP, with a confirmed diagnosis of type II diabetes mellitus and who agreed to participate in the study by signing the free and informed consent form (FICF). 14 individuals were excluded from the research, for the following reasons: failure to identify the address informed by community health agents, absence of the patient at home at the time of the visit and refusal to participate in the study.

3.1.5 Data collection

The study was carried out from January 2019 to March 2020. Information was collected through a questionnaire, containing open and closed questions, which was applied at the time of home visits. (Gil *et al.* 2008) claims that the questionnaire is the fastest and cheapest way to obtain information.

3.1.5.1 Data collection was divided into two stages

1st stage: Visit to the diabetic patient at home in order to carry out the invitation to participate in the research; application of the questionnaire, as well as blood pressure measurement and scheduling of the date for the capillary blood glucose test.

2nd stage: Home visit to perform fasting capillary blood glucose. The purpose of collecting clinical data such as weight and height was to obtain the body mass index (BMI). From the results obtained, it was possible to assess the presence of obesity and

classify individuals as to the risks of comorbidities. We used the values described in the weight classification chart, available in the WHO Obesity Guidelines in 2016 as a parameter for BMI analysis.

For the evaluation of blood pressure, the classification of the WHO regional centre, Basrah was used and for the classification of fasting blood glucose, we considered the recommendations of the WHO. The weight was measured using a digital scale with a capacity of up to 150 kg. Aneroid sphygmomanometer plus stethoscope was used to measure blood pressure. Fasting capillary blood glucose was measured using a digital glucometer and reagent strips from the brand Injex®.

3.1.6 Study variables

The variables used in surveys that employ the survey method refer to observable and measurable facts or phenomena. In this study, sociodemographic variables included: sex, age, occupation, race, education, marital status, who lives with them and monthly income. As for the variables related to the diagnosis, treatment and control of diabetes, the following were analyzed: family history of diabetes, length of illness, type of medication used in the treatment and possible non-adherence to drug therapy. Regarding the variables that characterized life habits, we registered: presence of hypertension, obesity and / or dyslipidemia, physical activity, use of tobacco, consumption of alcoholic beverages and control of food. Regarding anthropometric variables, weight and height were assessed. We also investigated the presence of chronic complications such as visual and kidney problems.

Data analysis: The collected data were recorded in spreadsheets using the Microsoft office excel 2010 program and the results obtained were presented through tables.

3.1.7 Ethical aspects

The research was submitted to the ethics and research committee of the Basrah University, Basrah, Iraq. The data collected will be used only for scientific purposes and

disseminated in a consolidated manner without any identification of the participating individuals. The researcher undertakes to maintain the absolute secrecy of possible information that may not be part of the study's proposal.

3.2 Methods

3.2.1 Socioeconomic profile

According to the registrations of the Teaching Hospital, Basrah University, 150 patients with DM II were treated during the study period, 120 of whom participated in the research. The distributions of socio-demographic and economic characteristics are described in the Table 3.1.

Among the patients interviewed diabetics, 78.3% were female. Similar data were observed in studies by, where the female gender presented a percentage of 78.4%, 76.7%, and 72.7% respectively. Some authors believe that the higher frequency of women with DM II is related to the fact that they are more attentive to the appearance of health problems, as well as seeking medical assistance earlier, which favors the diagnosis of the disease. In addition, a greater number of women reach adulthood and age.

Regarding the age group, there was a prevalence of diabetics aged over 60 years (51.7%), which is close to what was observed in the study by. Similarly, the study by (Ibarra-Costilla *et al.* 2010), which assessed the quality of life of patients with DM II with chronic wounds, also found a greater number of elderly diabetics older than 60 years (56%).

The incidence of diabetes is progressively higher with the aging process, therefore, the prevalence of the disease in more advanced age groups has occurred mainly due to the increase in life expectancy. In the study by (Alfred *et al.* 2013), where the prevalence and associated factors were analyzed to diabetes in 621 elderly people over 60 years of age, the results showed that the disease is present in 22.4% of the population in this age group. These data demonstrate the need for educational measures capable of promoting adherence to treatment and promoting metabolic control, since diabetes is the sixth most

common cause of death in the elderly. It is necessary that health professionals and managers act in the search for assistance that is also able to meet the particularities of the elderly.

Table 3.1 Distribution of patients with type II diabetes mellitus according to socio-demographic and economic characteristics

Variable	**No**	**%**
Sex		
Female	90	88.53
Male	60	52.10
Age		
<40 years	10	8.33
40 - 60 years	30	65.00
> 60 years	50	71.67
Marital status		
Married	50	85.00
Widower	10	16.67
Not married	10	10.00
Separate	15	7.00
Divorced	5	8.33
Occupation		
From home	50	41.67
Retired	15	33.33
Work in	10	16.67
Work out	15	8.33
Education		
Illiterate	50	41.67
Incomplete elementary school	10	33.67
Complete elementary school	10	16.67
Complete high school	15	15.33
University education	5	10.67
Family income		
1 Minimum wage	50	41.67
1 - 2 Minimum wages	15	21.67
3 - 4 Minimum wages	15	38.33
> 4 Minimum wages	10	6.33
Who do you live with		
With family	58	96.67
Alone	2	3.33

With regard to marital status, it was found that 39 (65%) were married, while 10 (16.7%) declared themselves widowed. These data are in agreement with the literature, according to which the percentage of married and widowed diabetics was 64.3% and 18.6%, respectively, in a study by (Rodrigues *et al.* 2011). Corroborating this scenario, also found that among 50 people with DM II belonging to the Diabetics Group, 68% were married

while widowers totaled 16%. The importance of marital status is highlighted by (Zhang *et al.* 2007), who found that the degree of morbidity and mortality is higher among widowers, divorced and unmarried compared to married ones, as the husband is most often the main supporting factor in maintaining the health of your spouse with chronic diseases. As for widowers, the loss of a partner can trigger other health problems such as depression and discouragement, which usually ends up interfering in the diabetic's response to treatment.

As for occupation, the majority of the researched population does not have a paid function, with a predominance of 25 people in the home (41.7%) and 20 retired people (33.3%). Only 10 individuals work outside the home (16.7%) and the rest were classified as pensioners (8.3%). Taking into account that the number of elderly people in this study was higher in relation to other age groups, it was expected that the percentage of retirees would be higher than that of people in the home. However, in other works in the literature, the percentage of "home" occupation, considering subjects with DM II, also prevailed, being around 41.3% and 58.6%.

Table 3.1 shows that the participants in this research had a low level of education, with 61.7% having only incomplete primary education and 16.7% being illiterate. During the application of the questionnaires, most people reported that they had little or no opportunity to study due to the fact that they had to work from an early age to complete their families' income. Low levels of education have also been observed in other studies with Diabetes Mellitus patients seen in public health services (Grillo and Gorini 2007), when interviewing 150 patients with DM II, found that 65.6% also had incomplete primary education. The authors also found that 18.4% of those surveyed were not literate. Similar data were seen in a study with type II diabetics in 2014, in which 62% of respondents did not complete elementary school and 15% were illiterate.

Reduced levels of education are described as serious public health problems, since they can impair access to information, so that learning opportunities regarding health care become smaller. In a study carried out with the objective of establishing the prevalence of DM and risk factors in adults, it was observed that the disease is predominantly present

among individuals with less years of study. Taking into account that health is influenced by factors related to education, low schooling can be characterized as one of the determinants of the lack of adherence to the treatment and control of DM II, increasing the risks of morbidity and mortality among subjects affected by the disease. (Abkenar *et al.* 2020) believes that people who have little information are also carriers of fears, myths and prejudices that only tend to aggravate their clinical health status. Thus, it is of fundamental importance that health care programs are planned based on the sociodemographic and cultural profile of the assisted individuals, with the main purpose of facilitating understanding by patients.

Regarding family income, it was observed that 78.4% of patients receive 1 to 2 minimum wages per month. This result characterizes a population with a socioeconomic deficit, since only 21.6% have a monthly income equal to or greater than 3 minimum wages. These data are close to the results observed of 90 patients with DM II interviewed, 66.7% had family income between 1 to 2 wages and only 6.7% received more than 3 salaries. The low income associated with low schooling further compromises the health conditions of patients with DM II, because few financial resources also interfere with treatment adherence, mainly because it hinders access to therapy and delays the preventive care of the disease.

Diabetics belonging to classes with low economic income are more predisposed to complications or injuries resulting from their pathology. This condition can also be justified by the lack of adequate nutritional planning, precarious social support, reduced ability to adhere to the recommended medication, difficulties in accessing recreational facilities that favor the practice of physical activities, as well as the acquisition of equipment for self-monitoring of blood glucose or other health equipment. Given this context, it is essential that health education actions aimed at populations with socioeconomic characteristics equal to or similar to those observed in this study are rethought, especially in relation to the guidelines for self-care, considering the social and cultural scenario of the community and taking advantage of the resources that it has according to its possibilities, thus seeking to benefit the diabetic patient with regard to the adoption of healthy habits. In the sample studied, 96.7% of diabetics live with a family

member or partner. Similarly, after evaluating the profile of the population with DM, found that 91.43% of the analyzed population also lived with their families. In the context of assistance to diabetics, the family is a fundamental institution, whether in the process of education contributing to the follow-up of treatment or emotional support in the face of the challenges that arise with the evolution of the disease. (Zanetti *et al.* 2008) believes that people with chronic illnesses who live with their families are less susceptible to feelings of loneliness and vulnerability, as well as to situations of risk resulting from worsening morbidity. Thus, for the family to really be able to assist the patient with diabetes in the management of the disease, it is important that the alternatives of care planning include the creation of bonds between health professionals with patients and their families, enabling the expanding knowledge for both involved and making the care process more effective.

3.2.2 Diagnostic time

The Table 3.2 below presents the data observed in relation to the time of diagnosis of diabetes.

Table 3.2 Distribution of patients with type II diabetes mellitus according to the time of diabetes diagnosis

Variable	**No.**	**%**
Diagnostic time		
<1 Year	10	3.33
15 Years	15	25.33
5 - 10 Years	25	43.33
> 10 Years	70	85.00
	120.00	100.00

Forty-five percent of respondents have had the disease for more than 10 years, a finding that is similar to the study by Groff (Groff *et al.* 2011). When interviewing patients with DM II in relation to the variable time of diagnosis of the disease, they found that 48% and 46.88%, respectively, also knew that they had been diabetic for more than 10 years.

The time of diagnosis is an important indicator in the study of people with DM II, because the longer the duration of the disease, the greater the prevalence of complications (Cortez *et al.* 2015), when analysing the association between the duration of the disease and the onset of DM complications, reported that the percentage of complications was higher among diabetic individuals over 10 years compared to those who had the disease for less than 10 years. The diagnosis time reported by the patients may not correspond to the real time of the establishment of the disease, since in most cases DM II is diagnosed late, which further increases the risk of developing complications. The diabetic foot, for example, one of the chronic complications of greatest social and economic impact due to its incapacitating character, had a prevalence of 49.4% among type II diabetics with a diagnosis time of 10 years or more in the study by (Vieira-Santos *et al.* 2008). Other studies estimate that after 15 years of illness, 80% of people with DM II will be identified with some degree of retinal damage and 20 to 35% will have neuropathy (Pouwer *et al.* 2010), when studying the emotional factors, quality of life and adherence to treatment in adults with DM II, realized that the time of illness also has a relationship with adherence to treatment however, this relationship is inversely proportional, that is, the longer the time of diagnosis of the pathology, the greater the difficulty in maintaining glycemic control and adhering to the prescribed guidelines. Low adherence to treatment associated with the duration of diabetes is the main determining factor in the course of micro and macrovascular diseases, thus increasing the prevalence of chronic worsening.

Still analysing Table 3.2, it is possible to observe that the population diagnosed with diabetes aged less than five years, represents 31.6% of the interviewees condition favourable to the treatment of the patient.

3.2.3 Family history and diabetes

Heredity in relation to DM II is shown in the Table 3.3.

Sixty-five percent of patients stated that they have a family history of DM II, a figure close to that found in the cross-sectional study by (Geetha *et al.* 2017), who, when tracing the epidemiological profile of type II diabetics, revealed that 66.2% had at least least one

family member with the disease (Roblejo and Delgado 2010). During the pharmacotherapeutic follow-up of 120 diabetic people observed that 65.9% of the patients followed also had relatives affected by diabetes.

Table 3.3 Distribution of type II diabetes mellitus patients according to family history of diabetes

Variable	No.	%
Family history		
Yes	75	85.00
Not	25	22.67
They do not know	20	15.33
	120.00	100.00

The presence of a family history is one of the main causes of risk for DM II. Although environmental factors play an important role in the development of the disease, evidence shows that genetic factors are considered determinants of this process. The genetic burden of type II diabetes is much more pronounced when compared to type I diabetes, with DM II agreement in 90% and DM I in 30% for univithelinous twins. People with a family history of DM II are 2 to 6 times more likely to develop the disease than those who do not have cases of diabetes in the family.

3.2.4 Relationship of family history with diabetes

The degree of kinship of family history with the patients interviewed in this study is shown in Table 3.4.

Table 3.4 Distribution of patients with type II diabetes mellitus according to the degree of kinship of the family history with DM II

Variable	No.	%
Degree of kinship		
Mother	70	33.33
Father	25	13.33
Father and mother	15	5.00
Brother	5	6.67
Uncle	5	6.67
	120.00	100.00

It is possible to observe that DM II is strongly associated with the maternal side, since 51.3% reported the mother as having the disease. This data is very similar to that of Gunaid (Gunaid 1999), who in a study with the Iraqi population in the south of the country, evaluated the family history of people with DM II, of which 48.4% had a diabetic mother. According to the authors, the importance of the maternal factor was reinforced by the results found in the second generation, where 17.2% of diabetic mothers had diabetic children in contrast to only 6.3% of fathers. In general, the chances for the development of DM II increase from 3.4 to 3.5 times in case where one parent has the disease and 6.1 times when both parents are diabetic. Several mechanisms have been described to explain the increased risk that women with DM II have in transmitting the disease to their offspring. However, so far the causes of this event are not fully understood. It has been suggested by some authors that the diabetic environment in the uterus is able to increase insulin secretion in the fetus, leading to the installation of insulin resistance, so that the individual later becomes diabetic. However, it is important to note that in addition to genetic factors, environmental factors are also involved (Majeed 2019).

3.2.5 Comorbidities associated with DM II

The occurrence of comorbidities associated with DM II is shown in Table 3.5.

Table 3.5 Distribution of patients with type II diabetes mellitus, according to associated comorbidities

Variable	**No.**	**%**
Hypertension		
Yes	70	85.00
Not	20	15.00
Dyslipidaemia		
Yes	21	35.00
Not	38	63.33
They do not know	1	1.67
BMI classification		
18.5 - 24.9 (Normal)	70	68.33
25.0 - 29.9 (Overweight)	25	43.33
30.0 - 34.9 (Grade I obese)	15	30.00
35.0 - 39.9 (Grade II obese)	5	7.67
40.0 or Higher (obese grade III)	5	6.67

Both BMI and dyslipidaemia was self-reported by patients during home visits, while nutritional assessment (overweight and obesity) was performed from the BMI calculation, the recommendations of the WHO are used. It is observed that BMI was the most prevalent comorbidity, affecting 85% of individuals with diabetes. The strong association between these two pathologies is evidenced in numerous national studies, always covering more than half of the researched populations. In the work of Ismail (Ismail 2014), BMI was present in 80.9% of individuals diagnosed with DM II. The same similarity was observed to the data of (Abdulrahman 2018), who found in the studied sample a prevalence of 80% of diabetic and hypertensive individuals. In Iraq, the prevalence of diabetes associated with hypertension increased from 1.7% to 2.8% between 1998 and 2008, with the Midwest and Northeast regions registering the most accentuated increase in this period coefficient. It is suggested, therefore, the expansion of disease prevention and health promotion actions, as well as greater intensification of the treatment of associated cases of DM and BMI, in order to avoid or minimize the occurrence of cardiovascular episodes, which are the most frequent complications in people who have such diseases. The ministry of health emphasizes that the risks of cardiac, brain, kidney, visual and neuropathy problems are twice as high in individuals with concomitant DMII and BMI in relation to those who have only one of these pathologies. This explains the fact that the aggregation of both diseases is the main cause of hospitalizations and mortality in our country.

Another risk factor that often accompanies DMII is dyslipidemia. In the participants of this study, disorders of lipid metabolism were less frequent compared to BMI, affecting 35% of patients. When investigated in other diabetic populations, the disease was present in 38.6% and 43.8% of cases. Dyslipidemia is often combined with DM II, which is the main risk factor for atherothrombotic diseases. The lipid profile in diabetic patients affected by this comorbidity is commonly characterized by an increase in triglycerides and LDL cholesterol with a decrease in HDL cholesterol, however, in some cases HDL-C values may remain normal. Elevated LDL-C levels contribute to decrease the sensitivity of peripheral insulin receptors, further aggravating the condition of DM (Mooradian 2009).

The excessive deposition of cholesterol on the artery walls, due to the increase in low density lipoproteins (LDL), results in the formation of atheromas and a consequent reduction of the vascular lumen. This condition predisposes the individual to atherosclerosis, which is mainly characterized by thickening of the arterial vessels and increased peripheral vascular resistance. Consequently, there is an increase in blood pressure, which can lead to atheroma rupture, increasing the risk of thrombosis and acute myocardial infarction.

According to Mansour (Al-Khayat *et al.* 2000), atherosclerotic disease is responsible for three out of four deaths among people with DM II, with 75% of deaths caused by cardiovascular diseases, 50% by coronary artery diseases and the remainder due to vascular diseases. Peripheral and cerebrovascular. The prevalence of dyslipidemia in patients with type II diabetes is mainly influenced by genetic and environmental factors and the presence of other diseases, in addition to DM.

Analysing the anthropometric variables (weight and height), Table 3.5 shows that the BMI values obtained indicate that more than 80% of the patients are overweight, among them, 33.3% are in the group of overweight and 48.4% were classified as grade I, II and III obese. These results are very similar to those of Mansour (Al-Khayat *et al.* 2000) who when analyzing the distribution of comorbidities in type II diabetics, found that overweight was also present in 83.2% of patients, with 34.4% being in the overweight range and 48.8% had some degree of obesity. Although BMI is only a preliminary method of verifying a person's weight condition, it can be the first indication that the person is not within the standards considered ideal for health, in addition to assisting in the assessment of risk for the development of others diseases. The high prevalence of individuals with DMII who are overweight or obese has been described by several epidemiological studies. The increase in the body mass index is closely related to the increase in glucose intolerance, contributing to the high incidence of diabetes cases and, consequently, dyslipidaemia, hypertension and cardiovascular problems. Several studies report that obesity and overweight associated with environmental and genetic factors are the main responsible for the increasing prevalence of DMII in the country.

There is consensus among some authors that the ingestion of foods with a high content of fats and carbohydrates of rapid absorption associated with greater urbanization, aging and physical inactivity are the main etiologic drivers of obesity. Thus, it can be said that the predominance of obese and consequently diabetic people has a positive correlation with an inappropriate diet, however, studies show that a sedentary lifestyle is a risk factor as relevant as eating habits.

In this context, the biggest challenge facing primary prevention programs in public services is to seek ways to minimize the risk factors capable of triggering the emergence of chronic non-communicable diseases, as well as providing adequate support for people with diabetes, encouraging the adoption of the practice physical activities and healthy eating habits, in addition to smoking cessation and alcohol consumption. Another challenge is to guide the population that, in addition to the treatment of diabetes mellitus, it is essential that the associated diseases be properly treated.

3.2.6 Medicines used to treat diabetes

The antidiabetic drugs used by the patients interviewed in this research are shown in Table 3.6.

Table 3.6 Distribution of patients with type II diabetes mellitus, according to the drugs used to treat diabetes

	No.	**%**
Medication		
Biguanides	60	26.32
Sulphonylureas	25	15.79
NPH Insulin	15	7.02
Biguanides + Sulphonylureas	10	36.84
Biguanides + NPH Insulin	5	7.02
Biguanides + Sulphonylureas + Gliptins	5	7.02

Ninety-five percent of patients responded positively when asked about the use of pharmacological therapy and 5% (n = 3) said they controlled the disease only by adopting healthy eating habits and practicing physical activities. The drugs reported by the participants in our study are shown in Table 3.6. The association of biguanides and

sulfonylureas was the most prevalent, being used by 36.8% of the subjects, while the use of biguanides in monotherapy obtained a percentage of 26.3 %. It is also noteworthy that 15.8% of respondents used only sulfonylureas and four used only NPH insulin. In the work of Mansour (Al-Khayat *et al.* 2000), whose objective was to evaluate the pharmacotherapeutic profile of type II diabetics treated in a Family Health Strategy program, there was also a predominance of the combination of biguanides and sulfonylureas 40%; followed by the use of biguanides 36% and sulfonylureas 24%. Relevant aspect for the high prevalence of the use of biguanides and also of sulfonylureas is probably related to the fact that both drugs are available in public pharmacies in different cities of Iraq. Another condition that possibly contributes to the observed pharmacological profile is the availability of these hypoglycemic agents in the Popular Pharmacy Program of private networks. In general, the criteria for choosing the antidiabetic should take into account fasting and postprandial blood glucose, the results of glycated haemoglobin tests, nutritional status (eutrophy, overweight or obesity), age, drug interactions (especially in polypharmacy cases), presence of other diseases or complications and the level of diabetes progression at the time of diagnosis. Therefore, it is important that each patient is analyzed individually, since despite the numerous existing therapeutic protocols, there is still no consensus established about an ideal drug therapy.

According to Motar (2017), many individuals who are diagnosed with DM II even in the early stages of the disease may not need pharmacological therapy, as glycemic control can be achieved only with lifestyle changes. However, the evolution of diabetes is marked by the loss of the secretory capacity of pancreatic beta cells, so that the prescription of drug treatment will eventually become necessary.

The achievement of glycemic levels close to normal is the main objective of drug therapy. In the monotherapy scheme, biguanides, represented by metformin, are the drugs of choice for most type II diabetics, especially for those who are elderly or who have other associated comorbidities such as SAH, dyslipidemia and obesity. In addition to helping to reduce plasma glucose levels, they significantly decrease microvascular complications. They are considered safe drugs because they do not lead to hypoglycemia or weight gain,

however, Motar (2017) emphasizes the importance of contraindicating the use of biguanides in people with renal failure.

Although biguanides are widely prescribed for individuals with DM II, studies by Mansour, Al-Khayat *et al.* (2000) showed a higher prevalence of sulfonylurea prescriptions. These drugs are also used as a first line in the treatment of diabetes, and are generally indicated for thin, asymptomatic people with fasting blood glucose levels below 300 mg/dL. Since the mechanism of action consists of increasing circulating insulin levels, normally, over time, there is a significant loss of the pharmacological effect of these agents due to the failure of the cells of the islets of Langerhans, making it necessary to exchange the sulfonylureas for another class of drugs or the association with other antidiabetics.

In cases where biguanides or sulfonylureas are insufficiently insufficient to achieve therapeutic goals, one of the recommendations of the Ministry of Health is that they be associated to replace monotherapy. The combination of these two classes of oral antidiabetics has shown great efficiency in the control of DMII, because in addition to acting in synergism, potentiating the reduction of blood glucose, they also increase protection against the occurrence of vascular complications.

A double-blind study comparing the efficacy of combined treatment with metformin and sulfonylureas and each of these drugs alone, showed that the combined therapy was significantly more effective than metformin or glyburide alone, in addition to reducing the dose of each medicine. It was also observed that patients who used both drugs concomitantly reached levels of HbA1c less than or equal to 6%. Regarding the use of insulin, the WHO highlights that the inclusion of this therapy is less frequent in patients with DMII, being initiated only when treatment with isolated or combined oral anti-hyperglycemic agents is not promoting adequate glycemic control or when the results of HbAlc tests are higher than 7% even with maximum doses of antidiabetics for a considerable period of time. All users of insulin or metformin-associated insulin who participated in this study had more than 10 years of diabetes diagnosis. A large number

of individuals with a disease duration of more than 10 years suffer failure secondary to oral antidiabetics, which makes it necessary to introduce insulin therapy (Omar 2010).

3.2.7 Medicines used to treat hypertension

Hypertension was the most common comorbidity among respondents. Table 3.7 shows the drugs used to treat this disease.

Table 3.7 Distribution of patients with type II diabetes mellitus, according to the medications used to treat systemic arterial hypertension

Medication	No.	%
Thiazide diuretics + Angiotensin II receptor antagonists	70	29.41
Thiazide diuretics + ACE inhibitors	25	21.57
Angiotensin II receptor antagonists	15	19.61
Beta-adrenergic blockers	5	15.69
ACE inhibitors	5	13.73

The antihypertensive medication regimens most used by patients with SAH were thiazide diuretics associated with angiotensin II receptor antagonists 29.4%; thiazide diuretics associated with angiotensin-converting enzyme (ACEI) inhibitors 21.6%; antagonists of angiotensin II receptors (ARA II) in monotherapy 19.6%; beta-adrenergic blockers in monotherapy (15.7%) and angiotensin II converting enzyme inhibitors also in monotherapy (13.7%), it is illustrated in Table 3.7. In the study by (Vijan and Hayward 2003) carried out with hypertensive and diabetic patients, there was also a higher prevalence of the aforementioned pharmacological classes.

3.2.8 Medicines used to treat dyslipidaemia

We also evaluated the use of medications for the treatment of dyslipidaemia, it is shown in Table 3.8.

Table 3.8 Distribution of patients with type II diabetes mellitus, according to the drugs used to treat dyslipidaemia

Medicine	**No.**	**%**
Statins	16	76.19
Fibrates	4	19.05
Statins + Fibrates	1	4.76

Just over 76% used only statins in their therapy and 19% used fibrates, followed by the association of statins + fibrates (4.8%). The predominance of the use of statins (73.2%) and fibrates (26.8%) was also reported in an epidemiological survey carried out in Iraq.

The choice of therapeutic class depends on the type of dyslipidaemia present. According to the recommendations of WHO, the use of statins and fibrates is appropriate in people with DM II, because in these patients the profile of lipid disorders is generally characterized by hypertriglyceridemia, reduced HDL cholesterol and increased LDL cholesterol. It is important that aspects such as age, presence of other risk factors, in addition to DM and possible drug interactions are also evaluated by the clinician when prescribing lipid-lowering drugs (Molnar *et al.* 2017).

3.2.9 Adherence to the use of antidiabetic drugs

The frequency of use of antidiabetic drugs is shown in Table 3.9.

Table 3.9 Distribution of patients with type II diabetes mellitus, according to the frequency of use of antidiabetic drugs

Frequency of use of antidiabetics	**NO.**	**%**
Every day	47	82.46
Only once in a while	10	17.54

We can observe that among patients who use pharmacotherapy 95% (n = 57), 17.5% do not adhere correctly to pharmacological treatment, since they do not take their

medications every day (Al-khayat *et al.* 2000). When interviewing 46 diabetic patients in a research of Saddam General Hospital in Tikrit found that 21.7% of people also did not adhere to drug therapy. This percentage was even higher in the study by (Al-khayat *et al.* 2000), where it was found that 33.3% of individuals with DM often forget to take their medication, which according to the authors characterizes a situation of low adherence to therapy. The lack of adherence to the proposed treatments substantially increases the development of acute and chronic complications, reducing the clinical benefit and quality of life of diabetics. As a direct consequence, there is a social and economic loss for both the country and the patient, mainly due to the increase in morbidity and mortality and costs with health services. In developed countries, only half of people with chronic diseases adhere to drug treatment. While in developing countries the estimates for this prevalence are even lower. According to (Agarwal *et al.* 2014), only 1/3 of the patients recognize the importance of following the therapeutic regimen.

With regard to DM II, there are countless factors capable of interfering with adherence to pharmacological schemes and, yet, there is no agreement between the authors as to which one has greater or lesser influence. The following stand out: the low level of education; reduced socioeconomic and cultural conditions; psychological factors; failures in the health system; difficulties in accessing prescription drugs; lack of social and family support; how health professionals communicate with patients and the complexity of the disease (Wahrburg *et al.* 2002).

The asymptomatic character of DM II is also considered a variable that makes treatment compliance very difficult. As it is a condition that does not usually because immediate symptoms, many patients create the false idea that they do not need drug therapy and that short-term behavior will have little or no negative impact in the future. In addition, because they do not accept their new condition, most diabetics feel unmotivated to adhere to the treatment, especially when faced with the fact that it will not bring the definitive cure of the disease.

(Fadheel and Mohammed 2016) believe that the lack of knowledge in relation to the antidiabetic agents used to control diabetes is closely associated with the patient's

difficulties in adhering to and maintaining self-care. When identifying the information that type II diabetics had about oral anti-hyperglycemic agents, they found that 32.2% of the interviewees did not know the name of the medication used; 51.6% did not take antidiabetics at the correct time and 71% responded unsatisfactorily when asked about the purpose and purpose of the medications used. In that same study, some patients also mentioned that they stop taking mediation "when they are well" or "when they feel nothing". In this context (Albasry *et al.* 2020) state that a greater understanding of individuals about the therapy used optimizes the adherence process and reduces the appearance of diseases arising from the evolution of DM.

Some authors point out that the amount of drugs prescribed, the presence of adverse effects and the lack of knowledge about the disease also strongly influence adherence to treatment. People with DM II are frequently affected by other comorbidities, which ends up resulting in an increase in the number of daily pills and, consequently, the possibility of the appearance of side effects. The lack of knowledge about diabetes leads the patient not to worry about the prevention of possible complications that may appear in the future and that bring suffering and reduced quality of life. In view of all the factors that can influence adherence to treatment, it is essential to adopt measures capable of raising awareness and encouraging diabetic patients to adhere to drug treatment. The health teaching and education process, when carried out properly, are the main contributors to therapeutic success. However, it is essential that health systems provide diabetes patients with specialized services that meet all their needs and strengthen the management of self-care.

It is necessary to know the sociodemographic and psychosocial characteristics of diabetic patients in order to plan and implement multidisciplinary actions that promote changes in behavior and favor the appropriate use of medications. (Damnjanovic *et al.* 2015) point out that health actions must also emphasize the importance of controlling diet and physical exercise, in addition to helping the patient to find ways to deal with difficulties related to the disease.

The education of diabetic patients regarding the importance of adherence to pharmacological regimes is a slow and arduous process, which requires permanent supervision by health professionals. In this sense, the pharmacist is seen as a key element in terms of facilitating aspects of adherence to drug treatment, both because of his proximity to the diabetic patient and because of the attributions given to them, because, in addition to the role of guiding the population on the correct use of medicines, it is up to the pharmacist to inform patients about the likely side effects, pharmacological interactions, relevant characteristics of DM II and the consequences of non-adherence, making them increasingly active in the self-care process (Khurshid and Othman 2014).

3.2.10 Chronic complications

Other aspects investigated in this study were the chronic complications possibly related to DM II, reported by patients during the application of the questionnaires (See Table 3.10).

Table 3.10 Distribution of patients with type II diabetes mellitus, according to chronic complications

Variable	NO.	%
1. Visual Changes		
Yes	50	43.33
Not	70	56.67
2. Renal Changes		
Yes	50	11.67
Not	70	88.33

Visual changes were the most frequent complications (43.3%), followed by renal changes (11.7%). It is worth mentioning that the prevalence of these complications was higher in patients with more than 10 years of disease and in those diagnosed between five and 10 years, respectively.

Similarly, in the cross-sectional study by (Mansour and Ajeel 2013) carried out with 318 patients with DM II, 42.8% of participants reported the presence of ophthalmic problems

and 12.9% of kidney problems. Data similar to the present study were also observed in the work by (Oliveira 2014), and of the 60 type II diabetics, 36% had retinopathy and 14% had nephropathy (Heydari *et al.* 2010), when characterizing diabetic people, found that 28% also had ophthalmologic complications (such as glaucoma, cataracts, diabetic retinopathy and blindness), while 8.8% had some type of renal disorder.

DM has always presented itself as an alarming problem for public health, whereas, as it is a progressive disease, over time it significantly decreases the quality of life. In the phase in which the occurrence of chronic complications occurs, there is a significant depreciation of physical, psychological and social functionality, which ends up causing a negative impact on the health and well-being of patients affected by the disease. Renal and ophthalmological diseases are very common in patients with DM II, especially in those who have BMI associated and who do not adhere correctly to the treatment. According to (Hodelín Maynard *et al.* 2018), at the time of DM diagnosis, 21% of individuals have retinopathy and around 60% develop the complication after 20 years of illness. Nephropathy, on the other hand, occurs less frequently, being present in 15 to 20% of subjects with DM II, however, it is considered the primary cause of chronic kidney failure in the world. In view of the prevalence of visual and renal disorders found in this study and the pertinent information reported in the literature, it is suggested the need for the implementation of preventive practices capable of instructing the diabetic patient on the importance of glycemic control and changes in life habits, in order to minimize the consequences of all complications that are associated with DM. For health professionals are vital elements to improve care for chronic conditions in a community. However, it is important that they are also trained and have sufficient knowledge to provide safe guidance to the population.

3.2.10.1 Life habits

The lifestyle habits adopted by the individuals who participated in this study are described in Table 3.11.

We observed that 80% of the interviewees do not practice physical activities; 10% smoke; 26.7% consume alcoholic beverages and 68.3% do not control their food. These results are in agreement with other studies found in the literature also performed with DM II patients. In the study by (Shakor *et al.* 2015) carried out with patients, 84.6% of the interviewees reported not developing any physical activity and 23.1% reported consuming beverages alcoholic. Only the number of smokers (19.2%) was significantly higher than that observed in our study. Another research found that 71.4% of individuals did not perform physical activities and 14.3% smoked. With regard to food, when investigating the risk factors for the appearance of complications related to DM II, observed that 69.7% of patients also did not control their food.

Table 3.11 Distribution of type II diabetes mellitus patients, according to lifestyle

Variable	**No.**	**%**
Practices physical activities		
Yes	50	20.00
Not	70	80.00
Smoke		
Yes	25	10.00
Not	25	56.67
Stopped	70	33.33
Consume alcoholic beverages		
Yes	25	26.67
Not	70	51.67
Stopped	25	21.67
Controls power		
Yes	50	31.67
Not	70	68.33

The WHO highlights that sedentary lifestyle, the adoption of inadequate diets, alcohol intake and smoking are among the main modifiable risk factors for the worsening of the health status of individuals affected by diabetes. With regard to the participants in our study, we believe that these risk factors become much more relevant, since significant percentages of patients have advanced age, SAH, dyslipidaemia, obesity or overweight and do not adhere to drug treatment.

The high rate of sedentary lifestyle observed can explain the high number of individuals with BMI above the levels considered normal among the participants of this research, as it was observed that 93.1% of obese diabetics and 60% of those considered overweight did not perform physical activities. Among the practitioners of physical activities 20%, one hundred percent reported walking as the only activity developed, with frequencies that varied from 2 to 7 days a week.

Regular physical activity brings numerous additional advantages to the diabetic patient, so it must be seen as an important ally to the therapeutic plan. Evidence shows that physical exercise increases insulin sensitivity, stimulates glucose uptake by muscle tissues, improves lipid profile, favors weight reduction, controls blood pressure and reduces the need for high doses of oral hypoglycemic agents, in addition to providing physical and mental well-being.

Some of these benefits were confirmed in the studies by (Silva and Lima 2002). The authors, when analysing the effect of physical exercise on glycemic control of type II diabetic individuals aged between 45 and 75 years, found a significant improvement in blood glucose, triglyceride, HDL-C and BMI levels. They also found a decrease in complaints of depression, insomnia and muscle pain, thus demonstrating that exercise can be considered an excellent non-pharmacological complementary tool for the treatment of diabetes.

Despite all the positive impact that physical activity practices have on the health of DM patients, the Ministry of Health emphasizes that they must be introduced regularly and gradually, in addition to being appropriate to the possibilities and limitations of each patient, considering the current state of health and the existence of possible complications. It is also stressed about the importance of physical exercise being guided by trained professionals, in order to prevent them from bringing potential health problems instead of good results.

Encouraging the abandonment of a sedentary lifestyle is one of the challenges of the National Health Promotion Policy. Education activities in favor of changing this lifestyle

should involve the patient, family members, society and the public sector. The latter being responsible for providing resources and political strategies aimed at creating programs capable of encouraging and facilitating the practice of physical exercises. Some authors defend the idea that the incentive to perform physical activities involves, for example, measures such as the creation of public spaces (bike paths, open-air gyms, walking tracks, multisport courts, environments for the practice of gymnastics, dance and recreational activities) in order to encourage people to be less sedentary and more physically. In addition to physical inactivity, cigarette use and alcohol consumption are also important variables to be analyzed in a diabetic population. The WHO states that such lifestyle habits can contribute substantially to the increase in rates of chronic diseases, often in a relatively short period of time.

Smoking, in addition to impairing the prognosis of people with DM, is considered a relevant risk factor for the onset of the disease. The relationship between smoking and the occurrence of diabetes is clearly evidenced among the patients in the present study, since both smokers and ex-smokers (43.3%) were already adept at smoking when DM II was diagnosed.

Studies show that smoking increases abdominal fat, decreases insulin sensitivity, reduces HDL-C and increases circulating lipid concentrations, predisposing the individual to hyperglycaemia and dyslipidaemia. Nicotine and tar are capable of causing damage to blood vessel walls, increasing the chances of the appearance of atherosclerosis and other diseases related to systemic circulation.

Diabetic smokers are frequently affected by peripheral obstructive arterial diseases (PAD), which consequently increase the probabilities of the development of complications such as retinopathy and diabetic neuropathy, in addition, according to ADA (American diabetes association), smoking is closely related to the incidence of cardiopulmonary and cardiovascular diseases, mainly in individuals who have DM II and SAH concomitantly. Thus, the WHO recommendation is that smoking cessation by patients with chronic diseases such as DM II be constantly encouraged by the health team

through the provision of appropriate guidelines and strategic initiatives capable of promoting people's awareness and changes of lifestyle (Temiz and Temur 2019).

In the case of the consumption of alcoholic beverages by individuals with diabetes, the consequences seem to be related to the amounts ingested, frequency and time of ingestion, however, the effects of ethanol in these patients are complex and require further studies. According to some authors, excessive alcohol consumption (> 30 g / day) promotes changes in blood glucose levels, increases blood pressure, increases the risk of cerebrovascular accidents and microvascular complications, alters the lipid profile, favors insulin resistance, obesity, weight gain, the occurrence of hypoglycemia and the appearance of metabolic acidosis.

It is also known that ethanol interacts with metformin, which can produce hypoglycemic crisis and lactic acidosis and with glibenclamide leading to the occurrence of disulfiram type reactions and changes in blood glucose levels. All the aforementioned interactions are considered potentially serious.

Despite the risks involved, the ADA stresses that individuals with diabetes who choose to consume alcoholic beverages must obey the limit of one dose (360 mL of beer; 150 mL of wine or 45mL of distilled beverage) for women and a maximum of two doses for men. In addition, it is important that ethanol intake be accompanied by a meal in order to reduce the chances of hypoglycemia. If the patient performs some physical exercise concurrently, it will also be necessary to monitor blood glucose levels.

Unlike other authors (Shi *et al.* 2013) believes that not all diabetic patients should be prohibited from drinking beers, wines or other types of drinks that contain alcohol, as long as the amount and manner of consumption are appropriate. Corroborating this opinion (Jallab and Kadhim 2020), states that the controlled and sensible intake of alcoholic beverages by patients with DM II is associated with improved hemostatic balance, increased insulin sensitivity, lower risk of developing atherosclerotic diseases, ischemic diseases and cardiovascular diseases, besides not causing disturbances in the control of weight and blood pressure. However, (Shi *et al.* 2013) points out that in the

case of diabetic individuals with hypoglycemic crises, diseases in the peripheral nerves, potential for substance abuse and in women with a history of breast cancer, alcohol consumption should be discouraged. The author also reinforces the importance of the patient being evaluated by an endocrinologist and remaining aware of the moderate intake of alcoholic beverages, without exceeding the permitted quantities.

Studies on the consumption of alcohol by diabetic patients are still scarce in the literature, and much of the existing knowledge comes from epidemiological research (Shi *et al.* 2013). Thus, it is believed that the results available in the scientific community regarding the subject should be evaluated and interpreted with caution, so that safe and reliable information is made available to the population and to those involved in health promotion and self-care. Regarding food control, self-reported by the participants of this study, we noticed that less than half 31.7% of the subjects follow an adequate diet, which characterizes a condition of low adherence to nutritional treatment. The objectives of obtaining healthy eating habits include promoting metabolic control and glycaemic levels, helping to maintain weight, reducing insulin spikes and the development of acute and chronic complications resulting from diabetes mellitus (Shi *et al.* 2013). Care with food is undoubtedly one of the most important variables for the treatment of the disease to provide positive results to its patients. However, people's difficulty in living with diabetes, lack of knowledge, poor socioeconomic conditions and the scarcity of nutritional recommendations by appropriate professionals in the public health system are barriers that end up limiting this process.

The diet is constantly cited as the greatest difficulty encountered by diabetic patients, in addition, studies show that 77.5% of women and 91.7% of men do not follow the ADA recommendations regarding the consumption of fiber and fruits and that 41.6% of DM patients of both sexes frequently eat sugar.

Complying with the required diet requires efforts and changes in attitudes that are usually acquired since childhood, however, the act of eating goes far beyond simple food intake. It is a complex process that involves emotions, values, feelings and not just the biological need to nourish the organism. Prohibiting the consumption of certain foods generates

discomfort, anguish, frustration, resentment and lack of pleasure for diabetic patients, which ends up threatening the autonomy and quality of life of these individuals, so that they start to neglect food care and other aspects related to the treatment of the disease. Thus, only the orientation of what food should be for a DM patient does not guarantee adherence to nutritional therapy. It is also necessary to understand the behaviours and feelings that influence or not motivate possible changes incorporated in their daily lives.

With regard to food planning, it must be adapted to the biological characteristics, financial conditions, age, sex and metabolic status of the diabetic patient. In general terms, it is recommended to reduce the consumption of fats and carbohydrates with rapid absorption and to increase the consumption of fibers and foods rich in vitamins and minerals. One should always give preference to whole foods or foods with a low glycemic index, in addition to replacing sugar with a sweetener.

According to (Kelsall *et al.* 2015), it is essential that all patients are evaluated and monitored by a nutritionist, and this professional is primarily responsible for the transfer of skills and food education of people affected by diabetes. It is essential that the diabetic individual gains responsibilities, autonomy, learns to deal with their disease and to manage their food in the best possible way. Changing lifestyle habits both in relation to diet and in relation to the other variables associated with DM is a long, gradual and continuous process, which requires motivation, planning and discipline. However, most of the time the patient ends up entering a context of ambivalence, that is, he starts to have to decide between what he wants to do and what really needs to be done. The emotional instability generated by this condition requires that the patient with DM also receive psychological counseling, in order to reduce their suffering, enable them to accept their new needs and guarantee their effective participation in the self-care process.

3.2.10.2 Blood pressure

The blood pressure values collected during home visits are shown in Table 3.12.

Table 3.12 Distribution of type II diabetes mellitus patients, according to blood pressure

Variable	No.	%
Blood pressure		
Normal <130 x <85 mmHg	18	30.00
Borderline 130-139 mmHg x 85-89 mmHg	16	26.67
Stage I SAH 140-159 x 90-99 mmHg	19	31.67
Stage II SAH 160-179 x 100-109 mmHg	5	8.33
Blood pressure		
Stage III SAH ≥ 180 x ≥ 110 mmHg	2	3.33

We found that only 30% of patients had blood pressure levels below 130 x 85 mmHg, which is considered the ideal BP value for patients with DM. The others 70% had BP above the recommended level (Saeed and Al-Dabbagh 2003) when interviewing 109 individuals with DM, found that 64.7% also did not have blood pressure levels within the limit recommended by the ADA. The need for diabetics to maintain lower BP values is justified by the fact that they are considered to be at high cardiovascular risk, moreover, it is demonstrated by some studies that the risks of complications, especially those of a chronic nature, decrease with the reduction of blood pressure levels. Evidence also points out that BP control is as effective as glycemic control in minimizing micro and macrovascular problems.

As previously mentioned, high blood pressure affects most people with DM II. It is responsible for the high incidence of retinopathy, neuropathy, kidney failure, stroke, coronary artery and peripheral vascular disease. It is also associated with an increase in cases of hospitalizations for chronic diseases, an increase in medical and socioeconomic costs. In association with diabetes it is considered one of the greatest health threats, leading to a decrease in quality and life expectancy while contributing to increased mortality.

According to some authors, the only way to prevent or mitigate the occurrence of all these aggravating factors and to guarantee the success of blood pressure control is through patient compliance with pharmacological and non-pharmacological treatment. However, this adherence depends on health actions that encourage and facilitate lifestyle changes.

The control of risk factors, such as SAH, dyslipidemia and obesity are considered key parts in reducing the morbidity and mortality associated with diabetes. Thus, it is necessary that the possibilities of intervention through educational and therapeutic measures are constantly expanded.

WHO emphasize the importance of advising diabetics and hypertensive patients on the reduction of daily consumption of sodium, sugar, foods rich in preservatives and dyes, embedded foods, canned foods and smoked; adoption of diets rich in fruits and vegetables; increased practice of physical activities; smoking cessation and ingestion of alcoholic beverages in order that these patients reach normal blood glucose and blood pressure levels, thus improving their health conditions.

3.2.10.3 Glucose

According to the American Diabetes Association in 2015, the fasting glycaemia of diabetic people must be less than 110mg / dL, and can reach the tolerable limit of 130mg / dL. Most of the patients in the present study had decompensated and higher glycaemic levels than those recommended, since 75% of the interviewees had blood glucose above the limit of 130mg / dL, it is shown in Table 3.13.

Table 3.13 Distribution of type II diabetes mellitus patients, according to fasting blood glucose

Variable	No	%	N (%)
Fasting blood glucose			
<110 mg / dL	20	18.33	15 (25.5)
110 - 130 mg / dL	5	6.67	
131 - 200 mg / dL	25	35.00	45 (75.0)
201 - 400 mg / dL	70	36.67	
> 400 mg / dL	5	3.33	

This reality can be motivated by the high rate of non-control of food, lack of physical activities, non-correct adherence to drug treatment and the presence of other associated comorbidities such as obesity or overweight observed in this research.

Correlating the glycaemic profile with the diet, we found that among the 41 patients who did not control their diet, 79% had fasting blood glucose greater than or equal to 131 mg / dL. We also observed that 46% of sedentary individuals were in the same glycaemic range. Ninety percent of patients who reported not taking antidiabetic drugs every day had fasting blood glucose off the limits recommended by the ADA. Finally, we found that fasting blood glucose was significantly lower in individuals with normal weight compared to obese or overweight individuals.

Glycaemic control is one of the main challenges in the treatment of patients with DM II. Literature data demonstrate that persistent hyperglycaemia is the primary factor for the development of chronic degenerations and pathological processes involving the disease. Metabolic and physiological changes resulting from uncontrolled blood glucose are characterized in the short term by hypoglycemia, hyperosmolar hyperglycemic coma and diabetic ketoacidosis, and in the long term by micro and macrovascular complications. Thus, so that the consequences of lack of glycemic control are reduced, it is necessary that diabetic patients carry out the treatment of the disease in a conscious manner, being aware of all the dangers that may arise as a result of decompensated metabolic states. Given this perspective, the importance of providing diabetes patients with information capable of promoting self-care and favouring glycaemic control is emphasized, greatly reducing the burden brought by the disease and improving the quality of life of this population (Al Hilfi *et al.* 2013).

Among the various alternatives suggested to facilitate the achievement of glycaemic goals, (Ali *et al.* 2008) highlight the institution of self-monitoring of blood glucose. According to the authors, glycaemic monitoring performed daily by the patient himself is capable of providing important tools for decision making in the face of episodes of hyper or hypoglycemia, in addition to allowing the recognition of possible glycemic fluctuations, so that patients are encouraged to adopt measures corrective measures to alleviate the occurrence of such situations, such as, for example, balancing the diet, taking the medications correctly and practicing physical activities, thus reducing the appearance of possible complications.

However, we know that most diabetic individuals, especially those with low financial conditions, have difficulties to acquire the glucometer and reagent strips to perform glycemic self-monitoring. In view of this reality, it is essential that the actions and strategic measures aimed at strengthening the treatment of diabetic patients are in line with the socio-cultural and economic context in which they are inserted. It is necessary to consider the needs and particularities of each individual in order to provide adequate tools and support, providing the improvement of the available therapy and successfully overcoming the difficulties imposed by the glycemic lack of control.

According to (Al-muttairi 2016), considering the unique conditions of people with diabetes enables the creation of bonds and joint responsibility in care, allowing the socialization of information and the search for contiguous solutions based on the difficulties presented. DM is undoubtedly a very complex disease, which requires changes in habits and the development of special behaviors to achieve therapeutic goals. The new obligations imposed by the disease end up leading to the experience of behaviors that hinder treatment adherence and the transition of lifestyles. Thus, the education process through a prepared multiprofessional team has been seen as the main tool to promote adherence to treatment, guarantee self-care and allow patients to self-control. However, it is necessary that the continuous reinforcement of the goals and objectives of the treatment of patients with diabetes be frequently planned, in order that changes in attitudes towards the disease remain throughout the individual's life.

3.2.10.4 Effect of olive oil in people with type 2 diabetes-case study of patients from Iraq

The Mediterranean diet is defined as the eating pattern characterized by the intake of olive oil as the main source of fat, a high ratio between monounsaturated / saturated fats, high consumption of fruits, vegetables, legumes and unrefined cereals, low consumption of meats and dairy products, consumption of fruit as the main dessert, moderate intake of wine at meals, and moderate consumption of fish. The Mediterranean diet improves cardiovascular risk factors, such as blood pressure, lipid profile, endothelial dysfunction, oxidative stress and thrombogenic status. In fact, previous analyses demonstrated a

reduction of the incidence of type 2 DM in healthy subjects with greater adherence to this global diet pattern. The protection of the Mediterranean diet against the incidence of diabetes has also been demonstrated in a cohort of myocardial infarction survivors.

Olive oil is the main source of monosaturated fatty acids (MFA) in the Mediterranean diet, with 55 - 85% made up of oleic acid and the oleic acid contained in olive oil usually represents 60 - 80% of all the intake of this fatty acid.8 But in addition, olive oil contains antioxidants, among which Vitamin E, carotenes and phenolic compounds stand out, among which are hydroxytyrosol and tyrosol, among others. These phenols, microconstituents of olive oil, are important in the development of insulin resistance and, finally, of the metabolic syndrome8. Recently, a reduction in the inflammatory activity of certain chronic diseases with an immunological background has been observed after the administration of olive oil (Mohammed and Mohammed 2014).

Different studies have shown the improvement in the metabolic profile of MFA in subjects with DM2 as well as the protective effects of these acids in particular on the development of cardiovascular disease. However, there is no comprehensive epidemiological study to date that has analyzed the association between the specific consumption of olive oil as an independent element and the risk of DM. Although other types of fats such as Tran's fats have been the subject of specific studies showing an increased risk of diabetes of 39% by increasing the contribution of Trans fats by 2% of total energy.

Polyunsaturated fatty acids and omega 3 specifically have been studied to explain their relationship with insulin resistance and glycemic control. However, the particular role of olive oil, as a source of Monosaturated fatty acids, on hydrocarbon metabolism and specifically in the incidence of type 2 DM is not clear, although it has been proposed as a key factor in the benefits provided by the Mediterranean diet on health. For this reason, and using data from the current study, we have evaluated the effect of olive oil consumption on the risk of developing type 2 DM.

3.2.10.5 Methodological design

Mode of investigation: The research is experimental, not blind, and longitudinal.

Population or sample: Sample tested in the previous chapter diagnosed for DM II, 37 of them agreed to participate in our study. It should be noted that a group of five patients was used as a control group, who abandoned the treatment for reasons of work and other activities. However, a blood sample could be taken at the end of the treatment, in which elevated glucose values were found.

Inclusion criteria: Adult patients with diabetes mellitus who need treatment are considered, who accepted prior informed consent, undergoing treatment with olive oil.

Exclusion criteria

- Patients with liver diseases.
- Pregnant women.
- People with glaucoma.
- Patients with type 1 diabetes.
- Children and the elderly.
- Diabetics who were under medical treatment.
- Diabetics taking oral antidiabetics.
- Diabetics who exercised.
- Diabetics who had low-sugar diets.

3.2.11 Preparation and presentation of the olive oil

The usual diet was initially assessed with a semi-quantitative questionnaire with 136 items, previously validated. The questionnaire offers 9 categories of frequency of intakes for each item, ranging from more than 6 times a day to never or almost never. Each questionnaire item also reported a size or portion. Specific questions were asked regarding

the consumption of olive oil used to dress salads, in fried foods or in dressing with pasta, and the type of fat used when frying was also specified. The consumption of the daily intake was estimated by multiplying the size by the frequency of consumption for each food item. The nutritional composition was taken from the most recent Iraqi food composition.

3.2.12 Assessment of non-dietary variables

The metabolic equivalent (MET) per week was obtained using the time spent in 17 activities and multiplying the time spent by the specific resting metabolic rate (MET score) for each activity. The amount of MET per hour for all activities was combined to obtain a total of MET-hours per week. These estimates were adequately correlated with energy expenditure objectively measured using a tri-axial accelerometer in the validation study carried out on a sub-sample of the cohort.

3.2.13 Biological sample

Blood serum, free of fat and hemolysis.

Laboratory materials: Automatic pipettes 10 µL, 20 µL, 2.5 µL, and 10 mL volumetric pipettes. Test tube 13x100 mL. Plasticized metal tube racks. Ligatures 5 mL syringe. Disposable needle 20 gx1. Sterile gloves. Bottle of medicinal alcohol. Cotton package. Sticking plaster.

4. RESULTS AND DISCUSSION

4.1 Results

The characteristics of the participants at the beginning of the study and according to quintiles of olive oil consumption are shown in Table 4.1, Table 4.2, Table 4.3, and Table 4.4. Among the participants with the highest consumption of olive oil there were more women, they were older, there were more ex-smokers, and they had vegetable consumption and lower consumption of fruits, sugary drinks and lower total energy intake. During the follow-up time, the number of incident diabetes cases was 120. We observed the group with the highest consumption of olive oil (quintile 5) of 1.11 (95% CI: 0.45-2.78) compared with the group with the lowest consumption (first quintile) (trend p 0.32).

Table 4.1 Initial characteristics according to quintiles of olive oil consumption

Variable	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
N	120	120	120	120	120
Olive oil consumption (g / d)	4 (3)	10 (1)	15 (2)	22 (3)	40 (14)
Age (years)	37 (12)	39 (11)	40 (11)	39 (11)	40 (11)
BMI (kg / m^2)	24 (3.4)	24 (3.3)	24 (3.4)	24 (3.5)	24 (3.5)
Sex (% women)	25	25	29	21	24
Tobacco (% current smoker)	1.1	2. 3	1.1	2. 3	2. 3
Tobacco (% ex-smoker)	25	29	30	30	35
Physical activity (METs-h / week)	26 (24)	25 (22)	24 (21)	25 (23)	23 (20)
Fruit consumption (g / day)	370 (393)	317 (253)	298 (245)	373 (311)	329 (254)
Vegetable consumption (g / d)	488 (343)	470 (312)	466 (279)	562 (342)	558 (325)
Alcohol consumption (g / d)	7.6 (11.8)	7.3 (10.4)	6.9 (10.3)	7.0 (10.4)	7.0 (10.5)
Intake of trans fatty acids (g / d)	1 (0.7)	1 (0.5)	1 (0.5)	1 (0.6)	1 (0.5)
Caffeine consumption (mg / d)	45 (43)	41 (38)	40 (37)	46 (40)	47 (41)
Sugary drinks (kcal / day)	0.28 (0.5)	0.21 (0.4)	0.18 (0.4)	0.19 (0.4)	0.18 (0.4)
Total energy intake (kcal / day)	2.703	2.279	2.058	2.451	2.361
Proteins (g / d)	119 (28)	103 (26)	96 (25)	108 (29)	100 (26)
Lipids (g / d)	105 (30)	88 (28)	81 (27)	100 (33)	105 (31)
Carbohydrates (g / d)	308 (86)	255 (77)	225 (74)	267 (89)	241 (78)
Hypertension (%)	7.2	7	7.8	6.2	6.4
Hypercholesterolemia (%)	13.8	17.8	18.8	17.3	18.6
Family history DM (%)	13.1	14.3	15.3	15.8	16.5
Sleep apnoea syndrome (%)	1.9	2.1	2.6	1.3	1.2

All values are mean (in parenthesis: standard deviation).

Table 4.2 Glycemic levels in the total population (n=37)

	Middle value	**Middle value**
	Minimum	Maximum
Glycaemia	80.2	193.2

Table 4.3 Glycaemic levels before and after treatment with olive oil

	Glucose level before treatment	**Glucose level after treatment**
No (*n*)	120	120
Minimum	108.56	67.79
Maximum	191.36	108.36
Median	145.26	82.48
Variance	596.95	146.13
SD	24.43	12.09

It is observed that the mean before the treatment with olive oil was 142.78 mg / dL and the mean after the treatment, 85.15 mg / dL.

Table 4.4 Glycaemia levels before and after treatment with olive oil in the control group

	Glucose before (mg / dL) (Average)	**Glucose after (mg / dL) (Average)**
1. Patient 1	147.24	151.3
2. Patient 2	146.25	148.4
3. Patient 3	146.23	155.2
4. Patient 4	147.22	148.4
5. Patient 5	148.2	150.3

Table 4.4. Illustrates Comparison of glucose values before and after treatment with Olive Oil. In order to apply a t-test for before and after samples, two tests must be performed: first a box plot is illustrated in Figure 4.1. In this case, it is observed that there are no discordant values:

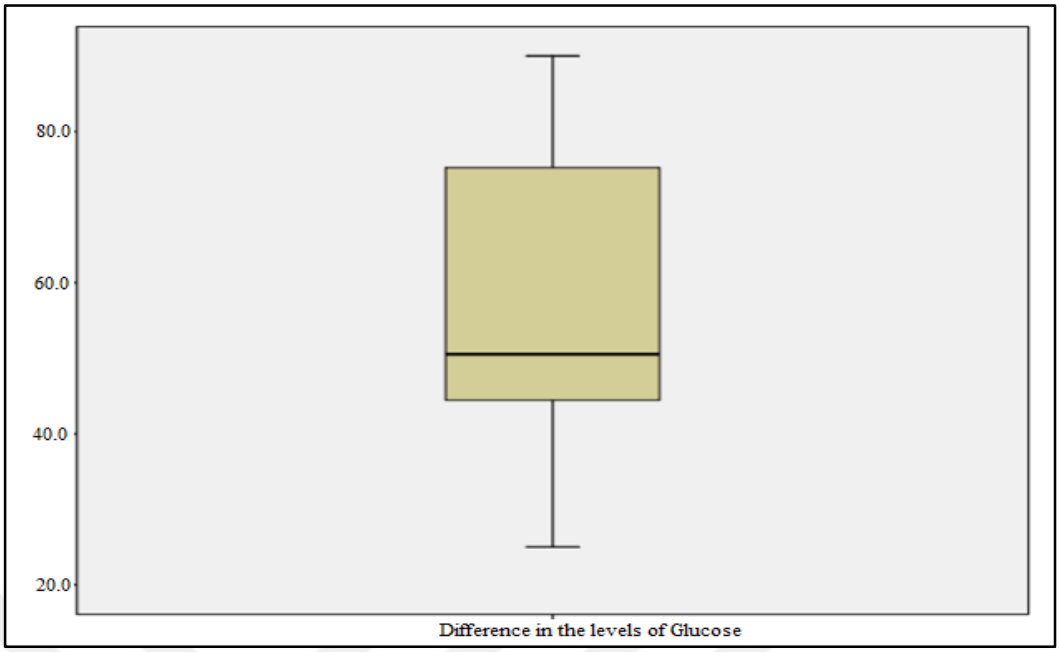

Figure 4.1 Box plot for the determination of difference in the glucose leves

Then a Kolmogórov test is applied, to verify if the data have a normal distribution. For this, the following hypotheses were used:

H_0: the data follow a normal distribution.

H_A: the data do not follow a normal distribution.

Table 4.5 Kolmogórov-Smirnov test for a sample

	Difference in glucose levels
No.	120
Z of Kolmogorov-Smirnov	0.923
Sig. asymptote. (bilateral)	0.361

a. The contrast distribution is normal.

b**.** They have been calculated from the data.

As sig. = 0.361 > 0.05, it is stated that the data follow a normal distribution. On the results of these two tests a t-test for paired samples can be applied:

H0: the glucose averages before and after the treatment are the same, the olive oil does not lower the glucose values.

HA: the glucose values before the treatment are higher than the values after the treatment, the olive oil significantly decreased the glucose values.

Table 4.6 T-test of related samples

	t	**gL**	**Sig. (bilateral)**
Glucose level before	17.4	36	0
After treatment with olive oil	77		

As sig. = 0.00 <0.05, it can be concluded that olive oil lowers glucose values.

4.2 Discussion

In the present work, the effect of Olive Oil was investigated, showing that there is a significant decrease in glucose levels when comparing the values before and after treatment with it. The results found in this study are shown below, compared with similar studies with other products. According to the literature available (Ahmed *et al.* 2019) to date, there is no analytical epidemiological study that has assessed the specific effect of olive oil, as a single element, and its relationship with the incidence of diabetes. Although it is true, we have some articles to which we will refer later that have valued the consumption of olive oil as the main source of MFA and its relationship with the metabolism of glucose, insulin and with the levels of incretions but not directly with the development of diabetes, as a newly diagnosed clinical entity in a prospective follow-up. And we also have studies that analyse the effect of different types of fat and the risk of DM, but without specifically assessing the consumption of olive oil.

No meta-analyses have been published on the association of olive oil and diabetes. Although a meta-analysis carried out by Garg that assessed the intake of MFA, sometimes from olive oil, demonstrated an improvement in the lipid profile and glycemic metabolism in those diabetic subjects with a diet rich in MFA compared to those subjects

also diabetics whose diet was rich in carbohydrates (CH). This improvement in glycemic metabolism translated into a decrease in baseline blood glucose of 0.23 mmol / L (95% CI: -0.39 to -0.06 mmol / L), in postprandial blood glucose (8.8 ± 2.1 compared with 10.1 ± 2.8 mmol / L in the group with CH ingestion ($p < 0.05$) and in the 24-hour glycemic and insulin profiles, although without improvement in insulin sensitivity, 16.5 ± 2.3 in the group rich in MFA compared with 14.7 ± 1.4 mmol/ kg/min in the group with a diet rich in CH ($p = 0.18$). Other studies have corroborated these results, showing an improvement in the glycemic metabolism of those subjects with type 2 DM who change from a diet rich in CH to a diet rich in MFA24. However, other studies have not found differences between these two diets and their direct effect on the glycemic and insulin response. Thus, in the study by (Capurso *et al.* 2018), the insulin resistance values measured in Homa IR after 12 months of follow-up with diets rich in CH and MFA, were 7.6 ± 0.8 and 7.8 ± 1.0 respectively, insulin values were 287 ± 7, and 251 ± 23.6 pmol / L respectively, and blood glucose values were 127 ± 5.5 and 142 ± 8.1 mg / dL respectively, with no significant differences found between both groups. These same results were obtained in an intervention study in diabetic subjects who were randomized to the two diets in question: the classic diet rich in CH and another diet rich in MFA, from olive oil, observing similar effects on metabolism glycemic. In this case, the glycosylated haemoglobin (Hb A1c) (%) values after following the HC-rich diet for 6 weeks was 6.5 ± 1.0 and the baseline glycemia (mg / dL) (164 ± 58), while in the group rich in MFA, Hb A1c values were 6.7 ± 1.3 and baseline blood glucose 177 ± 58, not finding statistically significant differences ($p > 0.2$). However, in another intervention study that compared the effect of three diets: one rich in MFA, another low in fat, and another control diet on glycemic metabolism and insulin resistance, it showed the benefit of the first over the rest, although it is not reflected if the source of MFA comes mainly from olive oil and in what proportion.

Other dietary intervention trials have demonstrated the benefit of a Mediterranean diet rich in olive oil. In the first of these, an improvement in cell function and insulin sensitivity is detected when the proportion of MFA over saturated fatty acids (SFA) from the diet is increased. This result was corroborated by that of (Soriguer *et al.* 2004) which suggests an improvement in cell function of measurable by insulin secretion.

Other studies have prospectively evaluated the effect of olive oil specifically in comparison with a diet rich in CH in insulin-resistant subjects. Thus, (Jamal and Ibrahim 2011) showed that a breakfast based on olive oil improved the levels of peptide-1 similar to glucagon (GLP-1) compared to an isocaloric diet rich in HC (4.22 ± 0.7, 1, 85 ± 1.1 respectively, p <0.05) and decreased postprandial blood glucose values (area under the curve (ADC) 7.8 ± 1.3 and 11.9 ± 2.7 mmol x 180 min / L, p <0.05 respectively) and insulin concentrations (ADC 1,004 ± 147 and 2,667 ± 329 pmol x 180 min / L, p <0.01 respectively) compared with a diet rich in HC.

Our results are somewhat consistent with those obtained in the study, who concluded that monounsaturated fat intake did not present any association with the risk of developing type 2 DM (Relative risk (RR)= 1.05; 95% CI: 0, 91-1.2 p = 0.52). Although in the North American study the specific effect of olive oil consumption was not specifically assessed, but only the intake of the different types of fat. Other sources of monounsaturated fat, mainly meat foods, are also important in the North American population.

There are possible mechanisms that have been invoked to explain a supposed beneficial action of olive oil consumption on risk. First, the beneficial effect of MFA on glycemic metabolism and on insulin resistance has been discussed. In a second term, the ability of olive oil to improve the response of incretins is postulated. Specifically, the antidiabetic hormone GLP-1 secreted by ileum L cells seems to increase, which acts at the pancreatic level by increasing glucose-dependent insulin secretion and at the peripheral level by increasing insulin sensitivity. A third aspect to consider would be the influence of fat intake on the lipid composition of cell membranes because by virtue of this composition it can affect the action of insulin through its receptor37. All these mechanisms have not yet received epidemiological support based on the observation of a reduction in the incidence of clinically diagnosed cases of type 2 DM associated with greater consumption of olive oil. It is possible that only virgin olive oil, rich in polyphenols, is capable of achieving these results. However, in our study using a food consumption frequency questionnaire, unfortunately we cannot differentiate between the different varieties of olive oil. There is a contrast between the striking protective effect presented by the global Mediterranean diet pattern in our cohort and the null association for one of the essential

components of this pattern, which is olive oil. However, it is well known that the overall Mediterranean diet pattern is often more important than the sum of its parts. It is also possible that much of the protective effect of this pattern is due to the high fibre content of those who follow it best38. But it is more likely that the number of clinical events observed together with the intrinsic difficulties of nutritional epidemiology make a longer-term follow-up necessary to reveal possible protection. However, our cohort represents the first epidemiological study in the world that has directly assessed the influence of drug use with a prospective design.

In the study carried out by (Pardo 2004) the effect of the extract of *Sessiliflorum solanum dunal* on hyperglycemia in 100 subjects is analyzed. The mean value at the beginning of treatment was 109.89 mg /dL, and after treatment with cocona, it was 85.35mg / dL, which corresponds to normal glucose levels. In the present study we have found a significant decrease in glucose levels after a treatment with olive oil in 37 subjects, who at the beginning of the study had a mean glucose level of 142.78 mg /dL (value higher than that found by Pardo, and after treatment, 85.15 mg / dL (slightly lower than that found by the researcher).

In another study, this time with cooking oil in the glycemic control of type 2 diabetics, (Soriguer *et al.* 2004) followed up for three months in a group of 105 patients. The values were recorded every month and, based on the t-student test, a significant decrease in glucose levels was demonstrated. Although in the present study a follow-up was not carried out per month, but only at the end of the three months, the results are very similar to those found by Soriguer. Conducted a study of the effect of the intake of *Solanum sessiliflorun* extract on glycemia in apparently healthy adults (126 people). This extract produces a decrease in the disease in people with type 2 diabetes, significantly reducing it from 95.02 mg / dL to 78.96 mg / dL.

5. CONCLUSIONS AND RECOMMENDATIONS

Most respondents were diagnosed with diabetes more than 10 years ago and had their mother as a carrier of the disease. Regarding the antidiabetics used, there was a prevalence of biguanides in association with sulfonylureas, however, some patients did not adhere correctly to drug treatment.

With regard to associated comorbidities, we observed a high frequency of hypertensive, obese and dyslipidemic individuals, some of whom also had visual or renal alterations. Thiazide diuretics associated with angiotensin II receptor antagonists were the most widely used drugs for the treatment of hypertension, as well as statins for the treatment of dyslipidemia.

Among those surveyed, the majority were sedentary, did not control their diet, had a decompensated glycemic level or had blood pressure above the recommended limits for diabetic people.

Based on the results obtained, it is evident the need to adopt educational measures that prevent the health problems of people with diabetes and act in the search for assistance capable of promoting self-care, alerting patients to changes in habits and greater control of the disease. However, it is not enough to just educate, it is also necessary to provide tools that allow healthier choices on the part of these individuals.

Multidisciplinary teams must act as facilitators and mobilizers in the education process, assisting users in the search for better health conditions and quality of life. In this perspective, the pharmaceutical professional can effectively contribute to the achievement of desirable results, both in relation to adherence to treatment and in relation to the reduction of acute and chronic complications, through guidance and monitoring of pharmacotherapy.

It is believed that the clinical and sociodemographic characteristics of selected patients may serve as a stimulus for the establishment of strategies regarding the management of diabetes, as well as assist in the planning of programs that promote awareness and provide knowledge related to the disease.

A study has been carried out on the efficacy of olive oil in patients with type 2 diabetes mellitus, with the aim of reducing hyperglycemia levels. Patients attended to Basrah medical College, who have this disease were chosen, a population with high risk of contracting other chronic diseases (risk cardiovascular disease, rhinopathy, diabetic nephropathy etc.). The study was conducted on 150 people. Treatment was performed on 120 of them, duly diagnosed with type 2 diabetes mellitus by the medical personnel. The biochemical determination of glycemia was performed by enzymatic method, and the t-student and Kolmogórov tests were applied as a statistical method. For the treatment with Olive Oil, the dose of 20 g was used in the form of salad, only once a week for a period of 3 months. At the end of this period, it was observed that the 120 patients considered in the study decreased glucose levels. The before and after laboratory determination ranged from 142.78 mg /dL to 85.15 mg /dL. As a control group, 5 patients who abandoned treatment for work reasons and other activities were considered. The glucose level was measured before and after, finding that the values had not decreased, compared to those who did undergo the treatment with olive oil.

From the study of treatment with olive oil in patients with type 2 diabetes from Iraqi residents, the following conclusions were reached:

1. Glycemia was determined in 120 fasting people, finding that they presented a minimum value of 80.2 and a maximum value of 193.20 mg /dL.
2. It was found that 120 people have type 2 diabetes, diagnosed clinically by medical personnel.
3. The glucose values before and after the treatment were 142.78 and 85.15 mg / dL.
4. The control group of five people had high glucose levels at the end of treatment.
5. The effectiveness of the olive oil treatment occurred in 100% of type 2 diabetic patients, as its elevated levels decreased.

5.2 Recommendations

1. Use the principles of olive oil in the treatment of other pathologies, such as obesity, hypercholesterolemia, among others.
2. Use the benefits of olive oil in other forms of presentation to make it a much more palatable food.
3. Recommend the study of other plants that Iraq provides, for the treatment of many diseases; something that, through this professional field, can be achieved: the study of plant resources through clinical analysis.

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