مجلة كامبريدج للبحوث العلمية: مجلة علمية محكمة
تصدر عن مركز كامبريدج للبحوث والمؤتمرات–العدد الرابع والعشرون– آب ٢٠٢٣–محرم ١٤٤٥
ISSN–2536–0027

THE ROLE OF TESTOSTERONE AND SOME BIOCHEMICAL MARKERS IN TYPE ٢ DIABETES AND METABOLIC SYNDROME IN MEN

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ABSTRACT

THE ROLE OF TESTOSTERONE AND SOME BIOCHEMICAL MARKERS IN TYPE ٢ DIABETES AND METABOLIC SYNDROME IN MEN

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May ٢٠٢٢

The testosterone hormone is responsible for reproduction and sexual function. In addition, data suggest that androgen ablation is an effective therapeutic strategy for prostate cancer in eligible individuals. With these new insights, it is necessary to place health concerns in a clinical framework that allows for more complete and integrated treatment. The results of the study showed that there is a meaning related to age and weight, with testosterone problems increasing as age increases. Low testosterone levels and diabetes mellitus are both related with an increased risk of prostate cancer. Men who have diabetes mellitus are often found to have low testosterone levels as well. A considerable number of individuals with type ٢ diabetes have low testosterone compared to the general population. However, no studies have been conducted in patients who also have diabetes mellitus in addition to low

testosterone to determine if testosterone therapy may enhance bone health. When it comes to healthy young males, the situation is different. Only a tiny proportion of people suffer from classical hypogonadism, which is caused by dysfunction of the hypothalamic-pituitary-gonadal axis that can be identified. The optimal amount of blood testosterone in men who do not have severe disease of the hypothalamic-pituitary-gonadal axis is debatable.

ÖZET

ERKEKLERDE TİP ٢ DİYABET VE METABOLİK SENDROMDA TESTOSTERON VE BAZI BİYOKİMYASAL BELİRTEÇLERİN ROLÜ

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Mayıs ٢٠٢٢

Testosteron hormonu üreme ve cinsel işlevden sorumludur. Ek olarak, veriler androjen ablasyonunun uygun bireylerde prostat kanseri için etkili bir terapötik strateji olduğunu göstermektedir. Bu yeni anlayışlarla, sağlıkla ilgili endişeleri daha eksiksiz ve entegre tedaviye izin veren klinik bir çerçeveye yerleştirmek gerekiyor. Çalışmanın sonuçları, yaş ve kilo ile ilgili bir anlam olduğunu, yaş arttıkça testosteron sorunlarının arttığını göstermiştir. Düşük testosteron ve diabetes mellitus, aynı risk artışı ile ilişkilidir. Diabetes mellituslu erkeklerin de genellikle düşük testosterona sahip olduğu bulunur. Testosteronun, düşük testosteronlu hastalarda kemik sağlığını iyileştirdiği gösterilmiştir, ancak düşük testosterona ek olarak diyabetes mellitusu olan hastalarda test edilmemiştir, tip ٢ diabetes mellituslu hastaların önemli bir kısmında referansa göre düşük testosteron seviyesi vardır. Sağlıklı genç erkeklere göre değişir. Sadece az sayıda hasta, tanınabilir hipotalamik-hipofiz-gonadal eksen patolojisi nedeniyle klasik hipogonadizmden muzdariptir. Belirgin hipotalamik-hipofiz-gonadal eksen patolojisi olmayan erkeklerde serum testosteron seviyesinin eşik değeri tartışmalıdır.

٢٠٢٢, ٤١ **sayfa**

Anahtar Kelimeler: Testosteron, Tip ٢ diyabet, RBS, Metabolik sendrom, Erkek kısırlığı

PREFACE AND ACKNOWLEDGEMENTS

I would like to thank my thesis advisor, Assoc. Prof. Dr. Şevki ADEM, for his patience, guidance and understanding.

١.

The testosterone hormone is responsible for reproductive and sexual function. Additionally, data indicates that androgen ablation is an effective therapeutic strategy for prostate cancer in suitable individuals. Moreover, it contributes to males having a much greater rate of coronary heart disease (CHD) than women. Men die from CHD at least twice as frequently as women. The connection remains throughout life, such that males have a greater incidence of coronary mortality than women at any age. This sex disparity has been ascribed to differences in the profiles of circulating sex steroids, with testosterone being the most evident. Both assumptions have been disproved via careful study. Estrogens do not provide cardioprotection, and there is no evidence that testosterone plays a substantial role in the genesis of prostate cancer or cardiovascular disease. However, these conventional views are firmly ingrained, and abandoning them would need extensive physician education (McIntyre *et al.* ٢٠١٩). The diagnosis and treatment of testosterone insufficiency will become a component of that holistic approach to senior men's health concerns. It is self-evident that testosterone therapy is not a panacea for elderly men. However, testosterone's importance to the pathophysiology of aging males has been grossly underestimated, if not ignored, for far too long. The sole rationale for testosterone therapy in senior men is a confirmed testosterone deficit, which is not uncommon in elderly men (Gromada *et al.* ٢٠١٨). Most elderly men with type ٢ diabetes have symptoms of metabolic syndrome. Type ٢ diabetes, hypertension, dyslipidemia, and an increased risk of metabolic syndrome are all conditions associated with insulin resistance. There is an inverse relationship between low testosterone and high glycosylated hemoglobin in diabetic males, and testosterone levels are lower in the latter group. This is not an artifact of medicine, such as statins (Zou *et al.* ٢٠١٨).

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Diabetes mellitus is more likely to develop in males with low plasma testosterone levels. Additionally, numerous large prospective studies have demonstrated that low testosterone levels in males are associated with the development of type ٢ diabetes. Numerous longitudinal population studies have established conclusively (Kleinert *et al.* ٢٠١٨, Deshmukh *et al.* ٢٠١٥). ١٣٠ participants (half with Type ٢ DM) with various degrees of disease activity will be examined in this study. Testosterone, RBS, Insulin, and a few biochemical markers will be determined in two groups of patients with variations in testosterone levels. ٦٥-year-olds with Type ٢ Diabetes Mellitus and ٦٥-year-olds without DM.

١.١ Aim of Study

This study aim to investigation the relationship between deficiency of vitamin B١٢, Magnesium and some biochemical markers in patients with diabetes mellitus and the changes in testosterone, B ١٢, Glucose and some biochemical tests with testosterone disorders in men diabetes mellitus

٢. GENERAL INFORMATION

٢.١ Diabetes Mellitus

'Diabetes mellitus' comes from the Greek terms diastos (siphon) and mellitus (sweetness). According to a survey of history, Apollonius of Memphis coined the term "diabetes" between ٢٥٠ and ٣٠٠ BC. The ancient Greek, Indian, and Egyptian civilizations noticed the sweet taste of urine in this state, which resulted in the spread of the term Diabetes Mellitus. Regrettably, diabetes remains one of the most prevalent chronic diseases throughout the world. It is the sixth common cause of death and is caused by an abnormally high level of glucose in the bloodstream, regardless of the type. However, depending on the kind of diabetes, the reason for elevated blood glucose levels varies and can have different types, as shown in Figure ٢.١ (Fang *et al.* ٢٠٢٠).

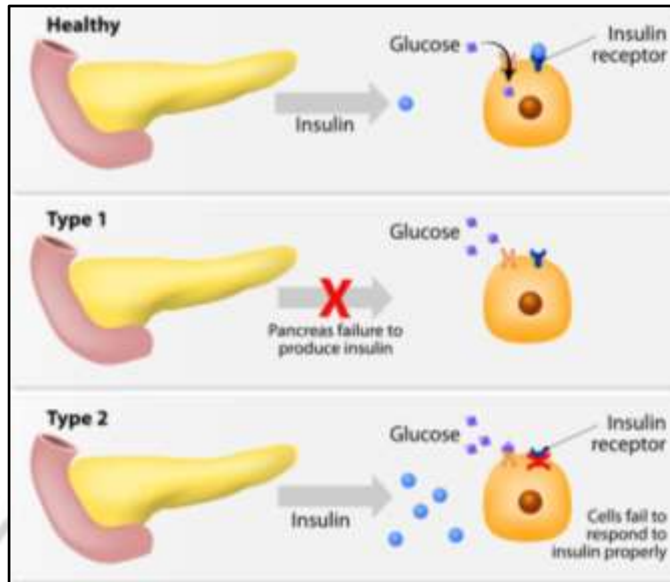

Figure ٢.١ The general types of Diabete Mellitus (Fang *et al.* ٢٠٢٠)
Diabete is a metabolic disease characterized by excessively high blood glucose levels. Type ١ and type ٢ diabetes mellitus are the most common. As a result of the vast differences between T١DM and T٢DM pathophysiology, each condition has its own set of causes, symptoms and treatments.
The next parts will go through the two kinds of diabetes in more depth (Cole *et al.* ٢٠٢٠)

٢.١.١ Type-٢ diabetes mellitus

Type ٢ diabetes, also known as non-insulin-dependent diabetes or adult-onset diabetes, was formerly known as such. The number of overweight or obese young people has increased in the last two decades, thus it has become increasingly common among children and adolescents. Type ٢ diabetes affects almost all diabetics (McIntyre *et al.* ٢٠١٩). The pancreas produces insulin when type ٢ diabetes develops. However, it is either insufficient or the body fails to use it properly. Fat, liver, and muscle cells are the most common places to find this gene. Type ٢ diabetes is often milder than type ١ diabetes. However, it has the potential to create major health issues, particularly in the kidneys, nerves, and eyes where the tiny blood arteries are located. Heart disease and stroke risk are greatly

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ISSN–2536–0027

increased in those with type ٢ diabetes (Oguntibeju *et al.* ٢٠١٩). Obese individuals (those who are more than ٢٠٪ overweight) are in risk of acquiring type ٢ diabetes and its consequences. Insulin resistance is frequent in obese individuals, which means that the pancreas must work harder to generate additional insulin. Maintaining normal blood sugar levels, on the other hand, is insufficient. Treatment includes eating a balanced and individuals require remidies. The two types of DM are shown in Figure ٢.٢ (Zou *et al.* ٢٠١٨).

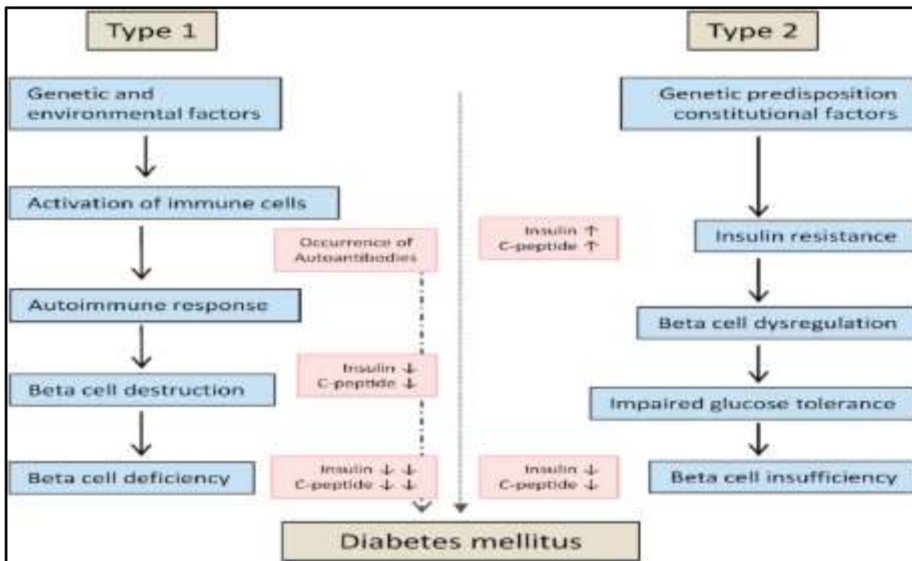

Figure ٢.٢ Comparison of both types (Zou *et al.* ٢٠١٨)

٢.١.٢ Gestational diabetes

The term "adult-onset" or "non-insulin dependent" diabetes" used to refer to type ٢ diabetes. However, as the number of overweight or obese young people has increased, it has grown increasingly prevalent among children and adolescents during the last two decades. The most often afflicted cells are those of the fat, liver, and muscle. However, shows the diagram of Gestational Diabetes. Obese individuals (those who weigh of ٢٠٪ more than their weight by the height) considered under increased risk of type ٢ diabetes and associated complications. Obesity results in insulin resistance, which requires the pancreas to work harder to produce additional insulin (Animaw *et al.* ٢٠١٧). On the other hand, maintaining normal blood sugar levels is insufficient. Additionally, certain individuals require medical treatment (Baz *et al.* ٢٠١٦).

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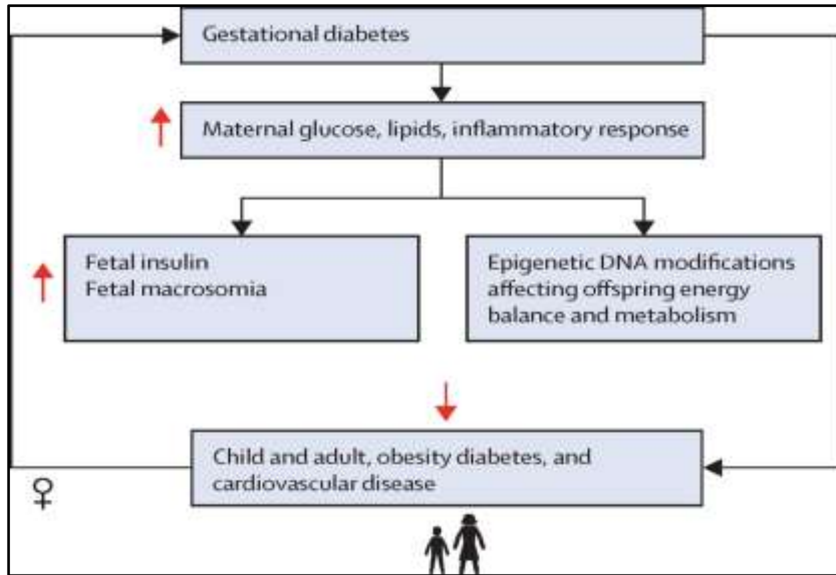

Figure ٢.٣ The diagram of gestational diabetes (Zimmer *et al.* ٢٠١٦)

٢.١.٣ DM and metabolisim

Individuals with diabetes have a different metabolism than healthy people. Type ٢ diabetes has reduced insulin effectiveness, whereas type ١ diabetes has extremely low blood insulin levels. Type ١ diabetics, as a consequence, must use alternative insulin delivery methods and is the most frequent (Katsarou *et al.* ٢٠١٧). Metabolism refers to the chemical events that occur indise organisms and are necessary for their survival. Those with diabetes have a metabolism that is nearly comparable to that of people who do not have diabetes. The only variation is the amount of insulin generated by the body and its efficacy (Animaw *et al.* ٢٠١٧). Glucagon is produced by the body when glucose is withdrawn from circulation to a dangerously low level, as previously mentioned (Kumar *et al.* ٢٠٢٠). Furthermore, as the quantity of insulin in the bloodstream increases, the body becomes increasingly resistant to it a process similar to how drug abusers develop tolerances to narcotics. As a result, if insulin resistance occurs, the phase ١ insulin response will be less effective (as discussed in non-diabetics). This, in turn, slows down insulin production, further exacerbating the situation. The consequences of the issue are amplified much more if the diabetic or pre-diabetic is used to eating relatively large amounts of carbs. It's also worth noting that increased sugar levels might make individuals feel sluggish and hungry since insulin

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is less effective at getting glucose into the cells that require it (Ighodaro *et al.* ٢٠١٨). When a person has type ١ diabetes, the proper functioning of the metabolism is reliant on the supply of insulin, which is often done via the use of an injection or an insulin pump. Insulin with a short acting time (also known as rapid-acting insulin) is designed to mimic the phase ١ insulin response, while insulin with a long acting time (also known as sustained-acting insulin) is designed to mimic the phase ٢ insulin response. On the other hand, due to the fact that this is often difficult to do, there may be instances in which high or low blood sugars emerge, which requires the diabetic to properly control their condition. Because insulin is involved in fat accumulation, individuals with type ١ diabetes may develop insulin resistance, a condition referred to as double diabetes (Katsarou *et al.* ٢٠١٧).

٢.١.٤ Type ٢ diabetes and metabolic syndrome

Type ٢ diabetes, heart disease, and stroke are all increased by the metabolic syndrome, which is a group of illnesses that occur at the same time and are linked to each other. High blood pressure, diabetes, abdominal obesity, and excessive cholesterol or triglyceride levels are just a few of the illnesses that may manifest themselves in people. Possessing even one of these diseases does not always imply that have metabolic syndrome (Bertuzzi *et al.* ٢٠١٨). However, it does increase the chance of developing a serious illness. Additionally, if get additional of these illnesses, the chance of developing complications such as type ٢ diabetes or heart disease increases. A high waist circumference is one of the noticeable signs. Furthermore, if the blood sugar level is elevated, it may have diabetes-related symptoms such as increased thirst and urination, tiredness, and impaired vision. The metabolic syndrome is strongly associated with being overweight or obese and being inactive (Keevil *et al.* ٢٠١٩). Additionally, it is associated with an issue known as insulin resistance. Normally, the food eaten is converted to sugar by the digestive system. As a result of impaired insulin response, glucose cannot enter cells as easily as it does in healthy people, resulting in insulin resistance. As a consequence, blood sugar levels rise despite the body's efforts to lower them by producing more insulin (Gromada *et al.* ٢٠١٨).

٢.١.٥ The effect on man

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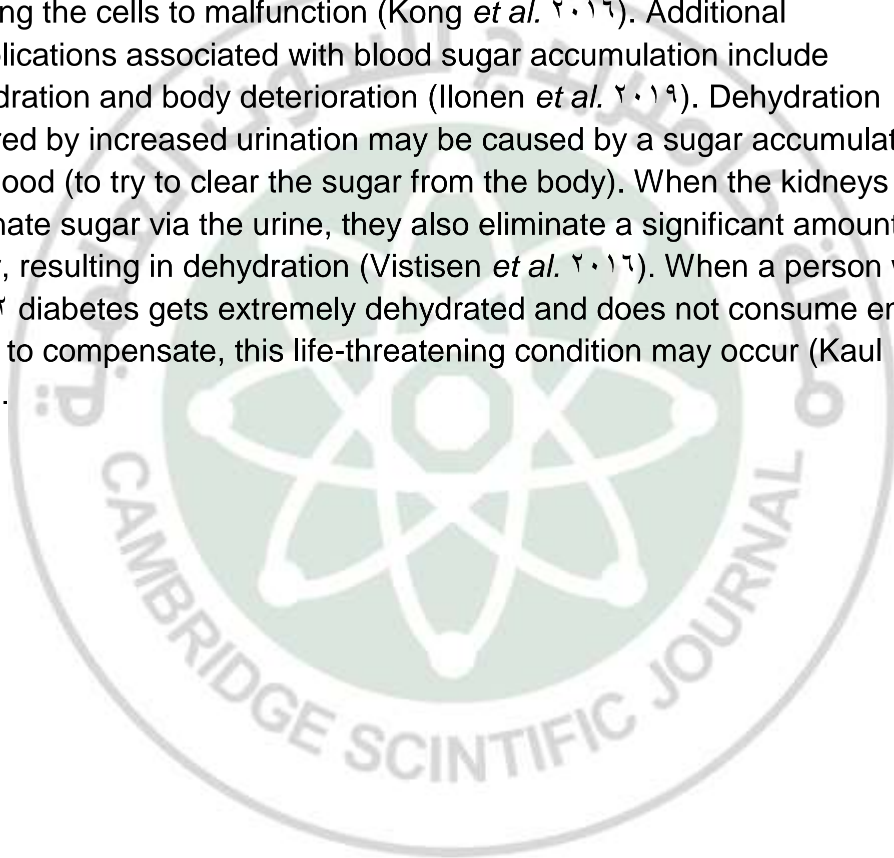
Diabetes prevalence has increased significantly in every state. Males had one of the largest increases, diabetes mellitus's effect on the male reproductive system is illustrated in Figure ٢.٤. Type ٢ diabetes is typically associated with an increase in risk as people age. Individuals who do not have any other risk factors should begin testing after the age of ٤٥. The type ٢ diabetes need the production of insulin, in contrast to type ١. However, this is insufficient, or their bodies do not recognize or utilize insulin properly. Insulin resistance is the technical term for this. When there is insufficient insulin or it is not utilised properly, sugar (glucose) cannot enter the cells to be used as fuel. Sugar accumulates in the blood, causing the cells to malfunction (Kong *et al.* ٢٠١٦). Additional complications associated with blood sugar accumulation include dehydration and body deterioration (Ilonen *et al.* ٢٠١٩). Dehydration occured by increased urination may be caused by a sugar accumulation in the blood (to try to clear the sugar from the body). When the kidneys eliminate sugar via the urine, they also eliminate a significant amount of water, resulting in dehydration (Vistisen *et al.* ٢٠١٦). When a person with type ٢ diabetes gets extremely dehydrated and does not consume enough fluids to compensate, this life-threatening condition may occur (Kaul *et al.* ٢٠١٥).



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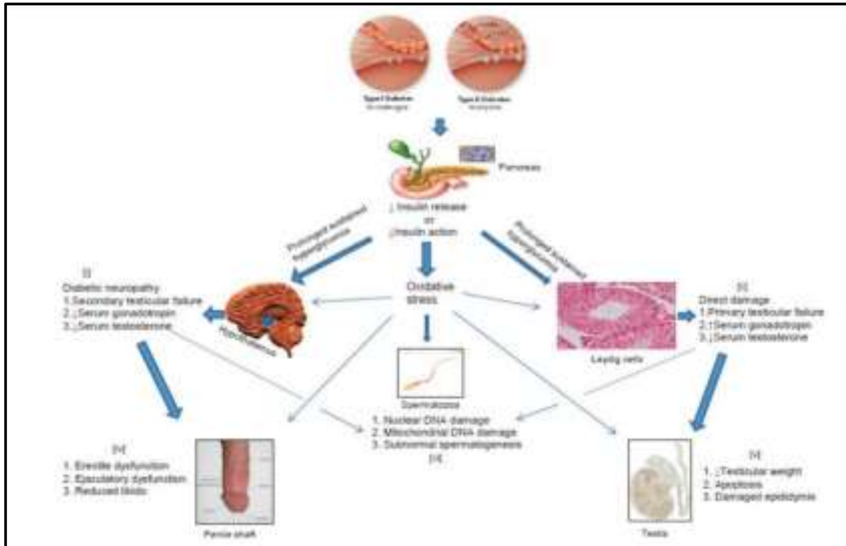

Figure ٢.٤ Diabetes melilotus's effect on the male reproductive system (Knipp *et al.* ٢٠١٦)

Body deterioration, however, is the elevated blood sugar levels that overtime can damage the neurons and vessels, putting them at risk of developing atherosclerosis (hardening of the major arteries). The heart attack or stroke can be the results of that. While treatment has advanced, diabetes control continues to be a problem, which is why specialists emphasize prevention (Petersmann *et al.* ٢٠١٨).

٢.١.٦ Diagnosis

Diagnosis is not the be-all-end-all. In certain instances, lifestyle modifications can completely manage the illness. Nonetheless, many diabetics require oral medicines to control their blood sugar levels. When these are insufficient, insulin (inhaled or injected) may be required, occasionally in conjunction with oral medications. The FDA has authorized a number of new medications (Palmiere *et al.* ٢٠١٥). Type ١ diabetes symptoms may appear suddenly, which is why it is important to monitor blood sugar levels as soon as they appear. Because different diabetes show symptoms more gradually or may be undetected, research has set screening criteria for these conditions. The American Diabetes Association recommends diabetes screenings for the following people (Wu *et al.* ٢٠١٦). If you are above the age of ٢٥, overweight, and have other risk factors including high blood pressure or are related to someone with diabetes or

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have polycystic ovarian syndrome, you should see your physician. Anyone over ٤٥ should get their blood sugar checked at least once, and if it's normal, then every three years after that. Women who have experienced gestational diabetes should have regular blood sugar checks for the next three years. Finally, those who have been diagnosed with prediabetes are advised to have their blood sugar levels tested on a yearly basis (Agrawal *et al.* ٢٠١٥). The first glucose tolerance test was performed. results were not promising. To begin the glucose challenge test, you'll need to consume a sugary solution. To find out whether it has diabetes, a blood test will be performed in an hour. The typical glucose challenge blood sugar level is less than ١٤٠ mg/dL (٧.٨ mmol/L), although this varies from clinic to clinic and from laboratory to laboratory when doing the test. Glucose tolerance testing on a follow-up basis. The blood sugar outcomes for each of the three hours of the test are greater than the stated standard norms, it will be diagnosed with gestational diabetes (Bianchi ٢٠١٩).

٢.١.٧ Treatment methods

Diet, exercise, and education are always the first things people with mild diabetes are told to do as part of their diabetes management plan. Obese people must lose weight if they want to live healthy lives. Type ٢ diabetics need medicine, as do those with high blood glucose levels despite making lifestyle changes, as do those with very high blood glucose levels, as well as those with type ١ diabetes (Kelly and Jones ٢٠١٥). Some diabetes consequences may be avoided by treating circulatory problems including hypertension and hypercholesterolemia. A low daily dose of aspirin is recommended for those who have risk factors for heart disease. It doesn't matter what cholesterol level a patient has if they have diabetes and are ٤٠ to ٧٥ years old since they will all be given a statin. People at a higher risk of heart disease who are under the age of ٤٠ or above the age of ٧٥ should also take a statin (Keevil *et al.* ٢٠١٩). A medical identification bracelet or tag worn by people with diabetes may notify medical personnel to the fact that the person has diabetes. Medical professionals may begin life-saving therapy sooner when equipped with this knowledge, especially in the case of accident or a shift in mental state. Hyperosmolar hyperglycemia and diabetic ketoacidosis are medical emergencies that may put a patient in a coma or kill them. Both diseases are treated in a similar manner, with intravenous fluids and insulin being administered

(Ruth *et al.* ٢٠٢٠). Because vigorous therapy to achieve these objectives raises the danger of blood glucose falling too low (hypoglycemia), these targets are modified for some individuals, such as the elderly, for whom hypoglycemia is particularly undesirable (Tyagi *et al.* ٢٠١٧). Patients with diabetes benefit greatly from being educated about the disease, being aware of the effect that diet and exercise have on blood glucose levels. Patients with any kind of diabetes must exercise strict dietary restraint. A nutritious diet with a variety of foods is recommended by doctors along with making an effort to keep your weight stable. Dieticians and diabetes educators can help people with diabetes develop a dietary plan that is tailored to their specific needs. This strategy involves avoiding simple sweets and processed meals, increasing dietary fiber, and decreasing the quantity of carbohydrate and fat-rich foods consumed (especially saturated fats). Insulin users should not go more than three hours without eating to prevent hypoglycemia. Protein and fat both contribute to caloric intake, but only carbohydrates have an impact on blood glucose levels. Diet-related materials are available from the American Diabetes Association, including recipes (Bianchi ٢٠١٩). Pre-meal insulin dosage is calculated by "counting" the amount of carbohydrate in the meal. For this reason, individuals with diabetes should work closely with a dietician who is familiar with the dietary needs and challenges of those with diabetes in order to find the best strategy for them. In spite of the fact that some experts suggest comparing carbohydrates according to their glycemic index, there is no evidence to support this approach (Saad *et al.* ٢٠١٧).

٢.٢ Testosterone

Humans and other animals both generate the hormone testosterone. Men's testosterone production is mainly controlled by their testicles. Testosterone production starts with the grow considerably throughout puberty and gradually decreases until about age ٣٠. Testosterone is frequently connected with sex drive and is required for the creation of sperm. Additionally, it has an effect on bone and muscle mass, men's fat storage, and even red blood cell formation (Smith *et al.* ٢٠١٨). Low testosterone levels, sometimes referred to as low T levels, can manifest themselves in a variety of ways in males, including sex desire diminished, deficiency of energy, weight gain, sadness, and irritability a poor sense of self-worth, a lack of body hair, and brittle bones (Bridwell-Rabb and

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Drennan ٢٠١٧). While testosterone production normally declines with age, other factors might contribute to a reduction in hormone levels. Testicular injury and cancer therapies such as chemotherapy or radiotherapy can all have a detrimental effect on testosterone production, the symptoms of low and high tesosterone are illustrated in Figure ٢.٥. Although its status as a male sex hormone, testosterone helps women with sex desire, bone density, and muscle strength (Langan and Good bred ٢٠١٧). An overabundance of testosterone, on the other hand, can induce male pattern baldness and infertility in women. The pituitary gland and the brain regulate testosterone levels. The hormone is generated and then circulated through the bloodstream to carry out its different activities (Harrington ٢٠١٧).

Procedure for the Examination

Bring all of the reagents, serum references, and controls to room temperature (٢٠ - ٢٧° C) before beginning the test. The technique for performing the test should be carried out by a skilled person or by a qualified expert.

١. Prepare the microplate wells for the calibration standard, the control sample, and the patient specimen to be tested in triplicate. Replace any unused microwell strips into the aluminum bag, seal it, and keep it between ٢ and ٨ degrees Celsius.
٢. ٠.٠٥٠ milliliters (٥٠ microliters) of the necessary calibrators, controls, and samples should be pipetted into the designated wells.
٣. To each well, add ٠.١٠٠ mL (١٠٠ mL) of the Insulin Enzyme Reagent. It is critical that all reagents be dispensed at the bottom of the microwell to ensure proper mixing.
٤. Gently swirl the microplate for ٢٠-٣٠ seconds to combine the ingredients. Wrap the container with plastic wrap.
٥. Allow for a ١٢٠-minute incubation period at ambient temperature (٢٠-٢٧°C).
٦. Use the wash buffer (see Reagent Preparation Section), decant (tap and blot) or aspirate ٣٥٠ mL. To get a total of three (٣) washes, repeat the process two (٢) more times. It is possible to utilize an automated or manual plate washer. Make sure to follow the manufacturer's recommendations for optimal use. To fill each well completely with water if a squeeze bottle is used, squeeze the

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container until it is completely full. Keeping air bubbles to a minimum. Remove the wash from the tub and continue the process two (٢) more times.

٧. After adding the substrate to the plate, do not shake it.
٨. Allow for fifteen (١٥) minutes of incubation at room temperature.
٩. ١٢. Divide the stop solution evenly between the wells and gently stir for ١٥-٢٠ seconds. Always add the chemicals in the same sequence as they are added to the wells in order to minimize reaction time discrepancies between wells.
١٠. Using a microplate reader, measure the absorbance in each well at ٤٥٠nm (using a reference wavelength of ٦٢٠-٦٣٠nm to eliminate well defects). The findings should be read no later than thirty (٣٠) minutes after the stop solution has been added.

In order to determine the quantity of Insulin in unknown specimens, a dose response curve is utilized in conjunction with other methods. Make a note of the absorbance value acquired from the printout of the microplate reader in the manner described. Plot the absorbance of each duplicate serum reference against its corresponding insulin concentration, measured in micrograms per milliliter, on a sheet of graph paper using a linear scale (do not average the duplicates of the serum references before plotting). After the points have been plotted on the graph, the best-fitting curve should be drawn over them. Finding the average absorbance of the duplicates for each unknown on the vertical axis of the graph, locating the point on the curve where they meet, and reading the concentration (in IU/mL) from the horizontal axis of the graph are the steps that need to be taken in order to calculate the insulin concentration for a variable that is not known (the duplicate of the unknown may be averaged as indicated). In the accompanying illustration, the point at which the average absorbance (٠.٦٢٤) crosses the dose response curve is when the concentration of insulin is ٦٦.٨ IU/mL. This occurs when the average absorbance is ٠.٦٢٤.

Statistics

After the sample collection was completed in accordance with the protocol of the companies that produced the cutlets, the statistical analysis was carried out using the SPSS program, version ٢٥, and the innova one way

test was used when the P value was less than ٠.٠٥. The results of the statistical analysis were presented in the form of a table.

٣. RESULTS AND DISCUSSION

Diabetes mellitus is one of the most prevalent diseases in the world. For this reason, studying the relationship of DM disease with change in testosterone is important. this study were to determine and investigation the role of testosterone in type ٢ diabetes and metabolic syndrome in men and the changes in testosterone, Glucose and some biochemical tests with reproductive disorders in infertile men. The group consists of ٦٥ subjects. Group A : ٦٥ with Type ٢ Diabetes Mellitus. Group B: ٦٥ without Diabetes Mellitus (Controls group). The diseased group was compared with a healthy group (control group).

٣.١ Results

٤.١.١ Age and weight

The results of study showed wchich performed with diabetes mellitus that the means of Age, weight and testeosterone for group A (٧٩.٤ ± ٥.١٨, ٧٣.٦ ± ٦.٤٤, ٥٥٩.٢ ± ١٤٢.٧ respectively) and group B was (٥٦.٩ ± ٨.٤١, ٩٧.٥ ± ١٠.٣, ١٩٨.٢ ± ٦٧.٣ respectively), the results age, weight and testeorone are illustrated in Table ٤.١, Figure ٤.١, Figure ٤.٢, and Figure ٤.٣, it seems a statistically significant when compared to controls. This indicates that testosterone is affected by age and weight. In this study the correlation (Table ٤.٥) between the β-asecretase test with age and weight was (r = ٠.٦٨٣**: r=٠.٥٨٣** respectively) at P < ٠.٠٥. There was an association with age and weight.

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ISSN-2536-0027

Table ٤.١ Shows means of age, weight and testeo for ٣ groups with controls

Variables	Group A n=٦٥	Group B n=٦٥	Total n=١٢٠	P value
Age (year)	٧٩.٤ ± ٥.١٨	٥٦.٩ ± ٨.٤١	٤٣.٩ ± ١٥.١	٠.٠٢٠
Weight (Kg)	٧٣.٦ ± ٦.٤٤	٩٧.٥ ± ١٠.٣	٨٨.٦ ± ١٢.٢	٠.٠٤١
Testo (CM)	٥٥٩.٢ ± ١٤٢.٧	١٩٨.٢ ± ٦٧.٣	٣٧٥.٨ ± ٢١٢.٦	٠.٠٣٩

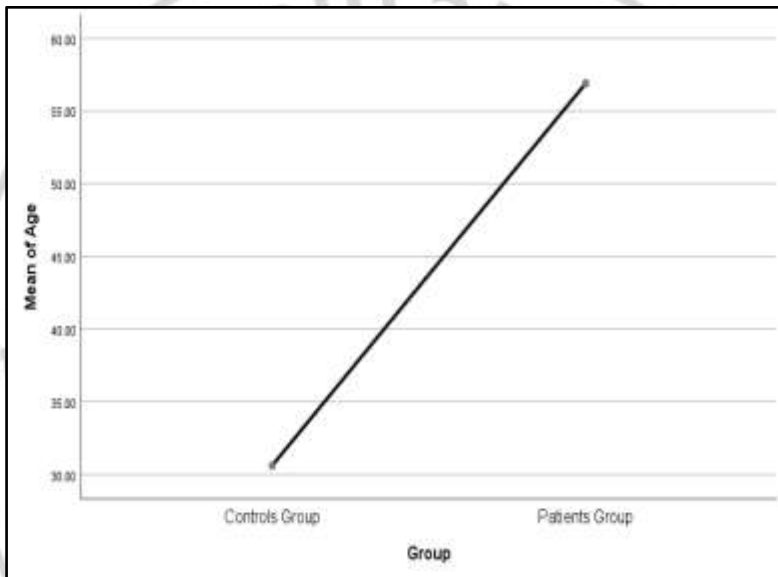

Figure ٤.١ Diagram shows means of age for ٢ groups with controls

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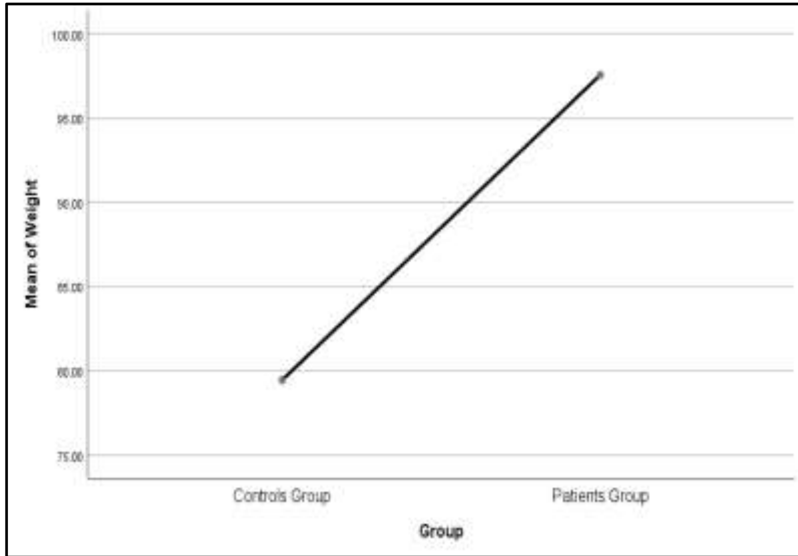

Figure ٤.٢ Diagram shows means of weight for ٢ groups with controls

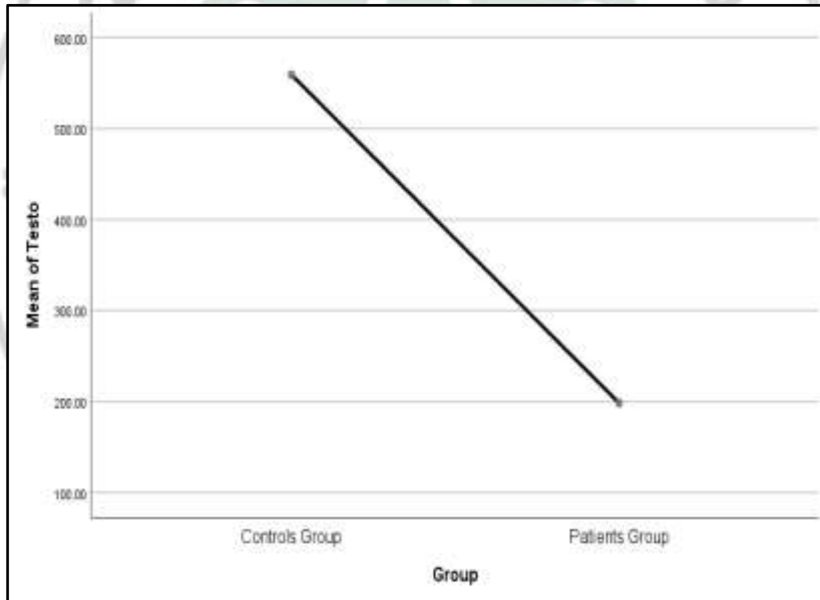

Figure ٤.٣ Diagram shows means of testosterone for ٢ groups with controls

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٤. CONCLUSION AND DISCUSSION

The aim of this study was to study the relationship between testosterone and some chemical tests in diabetes.
The results of the study indicated that there is a significance in relation to age and weight, as the older age increases, the more testosterone problems increase (Russo *et al.* ٢٠٢١). Diabetes Mellitus and Low Testosterone Levels Both Raise the Risk of Each Other Diabetes and low testosterone levels both increase the risk of developing diabetes. It is common for men who have diabetes mellitus to have low levels of testosterone, and it is also common for their spouses to have low levels of testosterone as well. Although it has been shown that testosterone may enhance bone health in people with low testosterone, no research have been carried out on patients who suffer from both low testosterone and diabetes mellitus (Russo *et al.* ٢٠٢١, Cheung *et al.* ٢٠١٥). When measured against reference ranges that are based on the testosterone levels of healthy young men, a significant number of people who have type ٢ diabetes mellitus have low levels of testosterone (Russo *et al.* ٢٠٢١, Cheung *et al.* ٢٠١٥, Rus Only a tiny proportion of these people suffer from classical hypogonadism, which is caused by disease of the hypothalamic–pituitary–gonadal axis that can be identified. The optimal cut-off value for serum testosterone in males who do not have apparent dysfunction of the hypothalamic–pituitary–gonadal axis is still up for debate (Cheung *et al.* ٢٠١٥).
There were also problems with testosterone and insulin hormone when gaining weight. Fats are also a problem, especially triglycerides. When it comes to the pathogenesis of metabolic illnesses such as obesity, testosterone is a critical hormone. Low testosterone levels, according to Kelly and Jones, are related with increased fat mass (especially central adiposity) and decreased lean mass in men, respectively. Metabolic dysfunction is connected with these physical characteristics, and testosterone insufficiency is associated with energy imbalance, poor glucose management, decreased insulin sensitivity, and dyslipidaemia (Kelly and Jones ٢٠١٥, Krstevska *et al.* ٢٠١٦). Triglyceride and low-density lipoprotein cholesterol levels in the mother's blood during the third

trimester of pregnancy are independent predictors of fetal macrosomia in diabetic women and women with gestational diabetes type ١. Therefore, the levels of maternal serum triglycerides and low-density lipoprotein cholesterol (LDL-C) that are measured in maternal blood samples that are given during the third trimester of pregnancy may be used to identify mothers who are likely to give birth to babies with a large head circumference (Krstevska *et al.* ٢٠١٦). Pearce and his colleagues discovered in ٢٠١٢ that the impact of dietary cholesterol in patients with diabetes has been understudied to this point in time. A hypo energetic high-protein high-cholesterol (HPHchol) diet was compared to a comparable quantity of animal protein (high-protein low-cholesterol, HPLchol) diet in adults with type ٢ diabetes to determine the impact on plasma lipids, glycemic control, and cardiovascular risk markers (Pearce *et al.* ٢٠١٢). Changes in fasting plasma glucose and glycosylated hemoglobin (HbA ١c) from the initial baseline test to the final follow-up test were significantly more favorable in patients who gained weight during the course of the follow-up compared to patients whose weight either decreased or remained the same throughout the course of the follow-up. The systolic and diastolic blood pressures, as well as cholesterol levels, increased considerably in the group that gained weight. Despite the fact that this cohort of type ٢ diabetes patients in Iran gained just a little amount of weight during a mean of ٩.٢ years, this weight gain was related with an increase in blood pressure and plasma lipids, as well as an improvement in glycemic control (Janghorbani *et al.* ٢٠١١).

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