



Prevalence and Risk Factors of Hypogonadism among Egyptian Men with Type 2 Diabetes: A Cross-Sectional Study

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Abstract

Background: Hypogonadism is a biochemical and clinical illness that correlates with reduced concentrations of testosterone in adult males. This syndrome can have a negative impact on the functioning of many organs as well as the life quality to a significant degree. There is a great connection between it and the progression of diabetes. The purpose of this research to investigate the prevalence of hypogonadism and the risk factors associated with it between men who have type 2 diabetes (T2D). **Patients and methods:** The investigation included an overall of 300 men who had been identified with type 2 diabetes and ranged in age from thirty to seventy years old. For the purpose of determining the level of androgen deficient in males, an Arabic version of the Androgen Deficiency in Aging Male (ADAM) questionnaire has been utilized. With the use of enzyme immunoassay, we have been assessed to determine the concentrations of hemoglobin FSH, LH, A1c, total in addition to free testosterone. **Results:** individuals diagnosed with type 2 diabetes have been separated into 2 groups: forty-eight individuals' sixteen percent had hypogonadism, while 252 cases eighty-four percent didn't have hypogonadism. After conducting a numerous logistic regression analysis to detect the factors that impact hypogonadism in cases based on their total testosterone and ADAM levels, it has been discovered that Hb A1c, age, body mass index (BMI), in addition random blood sugar are independent risk factors for the development of hypogonadism. The odds ratio for these factors was 0.95, 1, 1.1, 1.37, and the p value for each of these factors was 0.02, 0.03, 0.03, and 0.008 correspondingly. The ROC study of cut off values and the accuracy of indices for the total testosterone that was considered for the purpose of predicting hypogonadism based on the total testosterone plus Androgen Deficiency in Aging Male score being positive: The AUC was 0.98, with a p-value of less than 0.0001. The sensitivity was one hundred percent, and the specificity was 96.4 percent, when the cutoff value was equal to or less than twelve. The conclusion is that hypogonadism has a strong association with a number of potential variables that are correlated with diabetes. Between men diagnosed with T2D, the development of hypogonadism is independently associated with body mass index, age, HbA1c, in addition blood sugar.

Key Words: Hypogonadism; T2D; ADAM.

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Introduction:

Diabetes mellitus (DM) is a metabolic condition that is defined by the presence of hyperglycemia. This hyperglycemia can be associated with either impaired insulin secretion or defective insulin action, or both. Diabetes, which is characterized by persistently high blood sugar levels, is related to a very specific Great blood sugar may lead to a number of long-term complications, some of that are macrovascular complications, such as chronic limb ischemia, coronary artery disease, in

addition cerebrovascular strokes. Additionally, there are microvascular complications, like chronic renal illness, diabetic retinopathy, that can need regular dialysis, in addition to diabetic neuropathy [1]

type 2 diabetes can range from resistance of insulin with relative insulin insufficiency to insulin resistance with insulin secretory malfunction. The majority of people with type 2 diabetes have insulin resistance. Persons who have resistance of insulin and frequently have relative (Instead of absolute)



insulin shortage are considered to have this kind of diabetes, which accounts for ninety-to-ninety five percent of adults who have diabetes. This form of diabetes was formerly known as non-insulin dependent diabetes or adult-onset diabetes, type 2 diabetes. Although the particular etiologies of this sort of diabetes are unknown, it is likely that there are a great number of probable etiologies for this condition. The most of individuals who have this form of diabetes are obese, and obesity itself is a factor that contributes to insulin resistance to a certain degree [2].

Hypogonadism, also known as testosterone deficits is a biochemical and clinical disease that is recognized to be correlated with reduced levels of testosterone in adult male. This syndrome has the potential to negatively impact the functioning of many organs as well as the life quality [3]. The occurrence of clinical signs of hypogonadism and a reduced testosterone concentration (total testosterone below eight nanomoles per liter and/or bioavailable testosterone below 2.5 nanomoles per liter) was the distinguishing feature of overt hypogonadism. When symptoms were present and total testosterone levels were between eight and twelve nanomoles per liter or bioavailable testosterone levels were among 2.5 and 4 nanomoles per liter, the condition has been referred to as borderline hypogonadism [4]. The results of the cross-sectional researches that were conducted make it abundantly evident that hypogonadism affects among twenty percent and sixty-four percent of men who have diabetes. In general, there is a gradual and continuous reduction in the creation of testosterone between older people. Additionally, the frequency of hypogonadism differs considerably among various racial and ethnic groups [5]. The prevalence of hypogonadism in males who have T2D was observed worldwide at a significant rate. The current investigation has been conducted in the Minia governorate of Egypt with the purpose of determining the incidence of hypogonadism and the risk factors correlated with it between males who had type 2 diabetes in Minia governorate, Egypt.

Patients and methods

A total of three hundred people with type 2 diabetes participated in this prospective cross-sectional research; every one of the participants gave their verbal agreement to take part in the research. The cases who chose for this study were

individuals who had visited various hospitals associated with the Ministry of Health and Minia University for monitoring care during the months of January 2018 and June 2019. In line with the criteria established by the American diabetic association, cases are identified as having T2D [6].

In our research, the criteria for diagnosing hypogonadism include a reduced concentration of testosterone twelve nmol/L total testosterone 3.5 nanograms per milliliter), which is a reliable threshold for diagnosing late-onset hypogonadism (LOH) or free testosterone below 5.7 picograms per milliliter, as well as a positive outcome of screening with the Androgen Deficiency in Aging Male questionnaire [3,7]. There are two types of hypogonadism: 1ry hypogonadism, which is characterized by total testosterone levels over twelve nanomoles per liter and low luteinizing hormone levels below ten International Units per Liter, and 2ry hypogonadism, which is characterized by total testosterone levels above Twelve nanomoles per liter and low luteinizing hormone levels above Ten nanomoles per liter

Inclusion criteria included Cases who are male, have been identified as having T2D, are between the ages of Thirty and seventy, and are either receiving oral insulin or medication, or both. Exclusion criteria include: Certain case who met any of the following criteria involving: type 1 diabetes mellitus, a history of hypopituitarism, chronic inflammatory illness, chronic debilitating illnesses, or connective tissue conditions; taking any drugs which impact glucose metabolism, such as steroids or anti-psychotic medications; having autonomic neuropathy; having cancer; or being on testosterone alternate treatment.

All subjects have been subjected to: complete history taking and a comprehensive clinical examination are both performed. An Arabic version of the ADAM questionnaire, which was developed by Saint Louis University in Missouri, United States of America, in 2007, needed to be filled out by each and every case. This screening questionnaire, consisting of ten items, has been utilized to evaluate androgen deficiency in older males, taking into consideration morning erection in order to rule out the possibility of psychogenic erectile dysfunction. It was determined that a positive reaction indicated the occurrence of clinical hypogonadism depending on a reduction in libido, the strength of erections, or any 3 nonspecific questions. These questions can involve a diminish in mood changes, fatigability, muscle strength, in addition loss of height.



Utilizing a completely automated clinical chemistry auto-analyzer system called Konelab 20i (which was manufactured by Thermo-Electron Incorporation in Finland), the following examinations have been carried out: blood glucose concentration, hepatic and renal function tests, and a complete lipogram. Enzyme immunoassay was used to determine the concentrations of glycated hemoglobin, follicle stimulating hormone, luteinizing hormone, total in addition to free testosterone.

The sample size of the investigation has been determined by utilizing EPI – Info, which is a statistical program designed for epidemiology. The number of participants for the research has been determined based on the population size (the number of diabetic cases) and the percentage of illness incidence (the incidence of hypogonadism).

Statistical analysis

We used the Shapiro-Wilk test to determine whether or not the information's distribution was normal. A number of descriptive statistics, including frequencies, percentages the mean, and standard deviations, have been utilized in order to gather information regarding the base line characteristics laboratory information and clinical information. For the purpose of determining whether or whether there is a connection between hypogonadism and the demographic characteristics, laboratory and clinical information, analytical statistics were being utilized. The presentation of the quantitative information was done using the mean (standard deviation), whereas the presentation of the qualitative information was done using the frequency spreading. Specifically, the independent sample t-test has been utilized for the purpose of comparing means, and the Chi-square test has been utilized for the purpose of comparing proportions.

In order to determine the relevant predictors (independent probability variables) for hypogonadism (the target dependent factor), logistic regression analyses have been carried out. One of the cutoff points for all statistical tests that have been considered significant was a possibility of below 0.05, and each of the statistical tests were two-tailed. The graphic that gives the complete image of the trade-off among the sensitivity (true positive rate) and (1-specificity) (false positive rate) across a series of cut-off points is known as the receiver operating characteristic curve, or

ROC curve for short. For the purpose of evaluating the effectiveness of a test, the total area under the ROC curve is an only index. Typically, the overall performance of the medical test to correctly distinguish ill and non-diseased people is improved when the AUC is higher. Each and every analysis has been performed with the help of the statistical package for social science (SPSS, version 22).

Results

T2D was present in a total of 300 male participants in this investigation. Table 1 presents the socio-baseline characteristics of the individuals in question. individuals diagnosed with type 2 diabetes have been separated into 2 groups: forty-eight individuals (sixteen percent) had hypogonadism, while 252 cases eighty-four percent didn't have hypogonadism. 68.8 percent of the hypogonadal group were in the age group of forty-one to sixty years with a p value of 0.009, 43.3 percent of the hypogonadal group were smokers with a p value of 0.05, and twenty-five percent of the hypogonadal group were ex-smokers. 68.8 percent of the hypogonadal group received oral therapy for DM (p equal 0.05), 18.8 percent were receiving insulin, 56.3 percent of the hypogonadal group were diabetic for six to ten years with (p equal 0.0001), and 81.3 percent of the hypogonadal group were obese with (p equal 0.001). According to table 2, the group with hypogonadism has a greater body mass index, waist circumference grades, waist/height ratio, and waist/hip ratio, all of which have statistically significant values (p equal 0.001, equal 0.008, above 0.0001, equal 0.03).

Our findings showed that there were in significant variances among the 2 groups that were investigated with regard to the problems that are associated with diabetes mellitus (table 3). The following table presents a comparison among those who don't have hypogonadism and those who perform routine studies and have hypogonadism regarding (total Testosterone + Androgen Deficiency in Aging Male +ve): With a p value of 0.01 and greater than 0.0001, as well as 0.02 and greater than 0.0001, it was significant in creatinine, urea, eGFR, and SGPT. In terms of glycemic management, none of our hypogonadal cases have hemoglobin A1c levels that are greater than seven percent. However, among the non-hypogonadal group, 33.3 percent of patients have HbA1c levels that are greater than seven percent, and 66.7 percent of cases have HbA1c levels that are less than seven percent, with a p value of 0.0001. In terms of the correlation among particular investigations and



hypogonadism, it was shown that there was a significant association among hypogonadism and free testosterone, total testosterone, Androgen Deficiency in Aging Male score, in addition Follicle-Stimulating Hormone with p values of 0.001, above 0.0001, 0.003, and above 0.0001 correspondingly (table 5).

With regard to the outcomes of the multiple logistic regression analysis presented in Table 6, which compares cases with hypogonadism to those who don't have hypogonadism, it has been discovered that HbA1c, BMI, random blood sugar, in addition to age are independent risk factors for the progress of hypogonadism. The odds ratio for these factors is 0.95, 1, 1.1, 1.37, and the p value for each of these factors is 0.02, 0.03, 0.03, and 0.008 correspondingly.

Figure 1 depicts the Receiver Operating Characteristic analysis of the illustration of cut off values and the accuracy of indices for the total testosterone that has been examined in order to forecast hypogonadism regarding the total testosterone + ADAM score that was positive: When the cutoff value was equal to or less than twelve the AUC was 0.98, and the p-value was less than 0.0001. The sensitivity was one hundred percent, and the specificity was 96.40%. The Receiver Operating Characteristic analysis of the illustration of the cut off values and accuracy of indices for the ADAM score is shown in Figure 2. This analysis is used to forecast hypogonadism based on the total testosterone plus ADAM score being positive. At a cutoff value of zero, the AUC was 0.70, the p-value was less than 0.0001, and the sensitivity was one hundred percent. The specificity was 40.5 percent.

The ROC analysis of the illustration of the accuracy of indices and cut off values for the HbA1c that was researched for the purpose of predicting hypogonadism regarding total testosterone + ADAM score positive is displayed in Figure 3. At a cutoff value of less than 8.7, the AUC was 0.72, the p-value was less than 0.0001, and the sensitivity was 87.5 percent or 58.3 percent The ROC analysis of the illustration of the accuracy of indices and cut off values for the FSH that was researched for the purpose of predicting hypogonadism regarding the total testosterone + Androgen Deficiency in Aging Male score positive will be shown in Figure 4. The AUC was 0.60, with a p-value of 0.02. The sensitivity was seventy-five and the specificity was 48.88 percent, when the cutoff value was less than seventeen.

For the purpose of estimating hypogonadism based on a positive free testosterone + ADAM score, the ROC analysis of the illustration of the cut off values and accuracy of indices for the examined eGFR is presented in Figure 5. At a cutoff value of less than 82.5, the AUC was 0.39, the p-value was 0.003, and the sensitivity was 53.6 percent. The specificity was thirty-seven percent

TABLES and FIGURES

Table (1): Sociodemographic data of whole patient with type 2 diabetes mellitus.

Socio-demographic characteristics	Mean ± SD or N (%)
Age (years)	54.46 ± 9.46 (31-70)
Age groups	
30-40 (years)	33 (11%)
41-50 (years)	60 (20%)
51-60 (years)	126 (42%)
61-70 (years)	81 (27%)
Smoking	
Non smoker	141 (47%)
Smoker	96 (32%)
Ex-smoker	63 (21%)
Type of treatment of DM	
Lifestyle	21 (7%)
Insulin	60 (20%)
Oral antidiabetic	180 (60%)
Mixed (Insulin + oral)	39 (13%)
Complication of DM	
No	198 (66%)
Yes	102 (34%)
Classification of complication :	
Neuropathy	39 (13%)
Stroke	12 (4%)
IHD	27 (9%)
Retinopathy	21 (7%)
Nephropathy	3 (1%)
Hypertension	
No	204 (68%)
Yes	96 (32%)
Duration of diabetes (years)	7.73 ± 6.76 (0.1-27)
Duration of diabetes ranges	
≤ 5 (years)	156 (52%)
6-10 (years)	66 (22%)
11-15 (years)	51 (17%)
≥ 15(years)	27 (9%)
BMI (KGm/M ²)	31.22 ± 6.56 (21.1-40.8)
BMI grades (KGm/M ²)	
≤ 24.9 (KGm/M ²) average	27 (9%)
25-29.9 (KGm/M ²) overweight	102 (34%)
≥ 30 (KGm/M ²) obesity	171 (57%)
Waist circumference (Cm)	101.62 ± 13.67 (69-135)
Waist circumference grades (Cm)	
< 102 (Cm)	84 (28%)
≥ 102 (Cm)	216 (72%)
Waist/hip ratio	0.97 ± 0.06 (0.81-1.15)
Waist/height ratio	60.53 ± 7.71 (43-79)

BMI: body mass index , KGm : kilogram , M : meter , CM : centimeter



Table (2): Sociodemographic characteristics in type 2 DM patients with hypogonadism according to (Total Testosterone + ADAM +ve) versus those without hypogonadism.

Socio-demographic characteristics	Hypogonadism N=48	No hypogonadism N=252	p-value
Age (years)	52.87 ± 9.03	54.76 ± 9.52	0.2
Age groups			
31-40 (years)	3 (6.3%)	30 (11.9%)	0.009*
41-50 (years)	18 (37.5%)	42 (16.7%)	
51-60 (years)	15 (31.3%)	111 (44%)	
61-70 (years)	12 (25%)	69 (27.4%)	
Smoking			
Non smoker	15 (31.3%)	126 (50%)	0.05
Smoker	21 (43.8%)	75 (29.8%)	
Ex-smoker	12 (25%)	51 (20.2%)	
Type of treatment of DM			
Lifestyle	0 (0%)	21 (8.3%)	0.05
Insulin	6 (12.5%)	54 (21.4%)	
Oral	33 (68.8%)	147 (58.3%)	
Mixed	9 (18.8%)	30 (11.9%)	
Complications of DM			
No	33 (68.75%)	165 (65.5%)	0.01*
Yes	15 (31.25%)	87 (34.5%)	
Hypertension			
No	33 (68.8%)	171 (67.9%)	0.9
Yes	15 (31.2%)	81 (32.1%)	
Duration of diabetes (years)	7.15 ± 3.73	7.84 ± 7.20	0.5
Duration of diabetes ranges			
≤ 5 (years)			>0.0001*
6-10 (years)	15 (31.2%)	141 (56%)	
11-15 (years)	27 (56.3%)	39 (15.5%)	
6 (12.5%)	6 (12.5%)	45 (17.9%)	
> 15(years)	0 (0%)	27 (10.6%)	
BMI (KGm/M ²)	32.97 ± 7.88	30.89 ± 6.24	0.04*
BMI grades (KGm/M ²)			
≤ 24.9 Average	0 (0%)	27 (10.7%)	0.001*
25-29.9 Overweight	9 (18.8%)	93 (36.9%)	
≥ 30 Obesity	39 (81.3%)	132 (52.4%)	
Waist circumference grades (cm)			
< 102	6 (12.5%)	78 (31%)	0.008*
≥ 102	42 (87.5%)	174 (69%)	
Waist/hip ratio	1.01 ± 0.07	0.96 ± 0.05	<0.0001*
Waist/height ratio	62.70 ± 4.68	60.11 ± 8.10	0.03*

* Significant level of p- value is < 0.05
 * p value of frequency was calculated by using chi-square test.
 * p value of means was calculated by using independent sample t-test.

Table (3): The classification of complications between the hypogonadism according to (Total Testosterone + ADAM +ve) versus those without hypogonadism.

Diabetic complications	Hypogonadism N=48	No hypogonadism N=252	p-value
All number of patients complaint of complications	15(31.25%)	87 (34.5%)	
Neuropathy	6 (12.5%)	33 (13.09%)	0.9
stroke	3 (6.25%)	9 (3.57%)	0.4
schematic heart disease	3 (6.25%)	24 (9.52%)	0.6
retinopathy	3 (6.25%)	18 (7.14%)	0.8
nephropathy	0 (0%)	3(1.19%)	0.4

Table (4): comparison of Routine investigations in hypogonadism group according to (Total Testosterone + ADAM +ve) versus those without hypogonadism.

Routine investigations	Hypogonadism N=48	No hypogonadism N=252	p-value
Urea (mg/dL)	36.87 ± 9.71	32.42 ± 11.28	0.01*
Creatinine(mg/dL)	1.08 ± 0.19	0.95 ± 0.22	<0.0001*
eGFR(ml/min/1.73 M ²)	82.96 ± 19.95	89.79 ± 18.57	0.02*
SGOT(Iu/L)	23.56 ± 11.95	24.20 ± 15.73	0.7
SGPT (Iu/L)	27.68 ± 13.24	20.01 ± 8	<0.0001*
HbA1C (%)	10.01 ± 1.60	8.39 ± 2.17	<0.0001*
HbA1C ranges (%)			
< 7	0 (0%)	84 (33.3%)	<0.0001*
≥ 7	48 (100%)	168 (66.7%)	
HDL (mg/dL)	35.37 ± 6.40	37.34 ± 9.57	0.2
LDL (mg/dL)	149.43 ± 41.47	142.27 ± 42.69	0.3
TGS (mg/dL)	180.93 ± 51.75	202.05 ± 85.64	0.1
Cholesterol (mg/dL)	223.43 ± 41.01	224.96 ± 45.70	0.8

* Significant level of p- value is < 0.05
 * p value of means was calculated by using independent sample t-test.

independent sample t-test.

Table (5): relation between specific investigations and hypogonadism according to Total testosterone of the studied group.

specific investigations	Hypogonadism N=48	No hypogonadism N=252	p-value
Free testosterone (pg/mL)	5.58 ± 3.25	7.42 ± 3.62	0.001*
Total testosterone (nmol/L)	9.09 ± 2.87	26.68 ± 12.63	<0.0001*
SH(IU/L)	8.42 ± 4.26	9.25 ± 4.68	0.003*
H(IU/L)	11 ± 5.45	12.72 ± 6.06	0.06
DAM score			
Positive	48 (100%)	150 (59.5%)	<0.0001*
Negative	0(0%)	102 (40.5%)	
Total Testosterone level			
Normal	0 (0%)	243 (96.4%)	<0.0001*
Low	48 (100%)	9 (3.6%)	

* Significant level of p- value is < 0.05
 * p value of frequency was calculated by using chi-square test.
 * p value of means was calculated by using independent sample t-test.

Table (6): Multiple logistic regression analysis for factors affecting Hypogonadism among patients according to (Total Testosterone + ADAM +ve) versus those without hypogonadism

Independent variables	Adjusted odds for multivariate (95% CI)	P-value
Age (years)	0.95 (0.91-0.99)	0.02*
Random blood sugar (mg/dL)	1 (1-1.01)	0.03*
BMI(KGm/M ²)	1.1 (1-1.19)	0.03*
Waist circumference (Cm)	1 (0.96-1.05)	0.8
HbA1c (%)	1.37 (1.08-1.74)	0.008*
HDL(mg/dL)	0.95 (0.91-1)	0.06
TGS (mg/dL)	0.99 (0.99-1)	0.2
FSH (IU/L)	0.94 (0.88-1)	0.08
LH (IU/L)	0.99 (0.91-1.08)	0.8

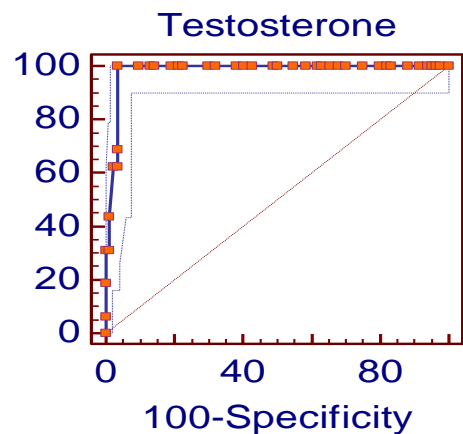


Figure (1): Roc curve analysis of total testosterone level in hypogonadism according to Total testosterone.



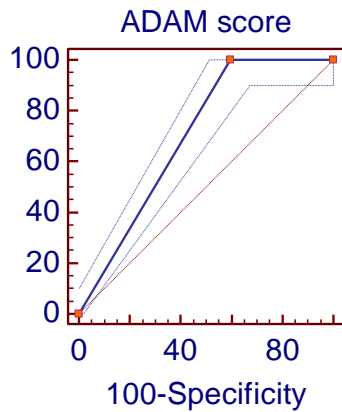


Figure (2): Roc curve analysis of ADAM score in hypogonadism according to Total testosterone.

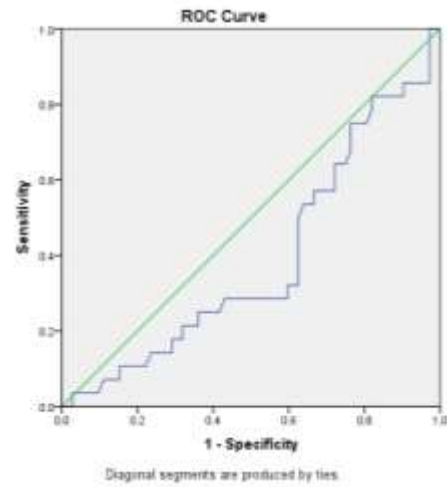


Figure (5): Roc curve analysis of e GFR in hypogonadism according to Free Testosterone

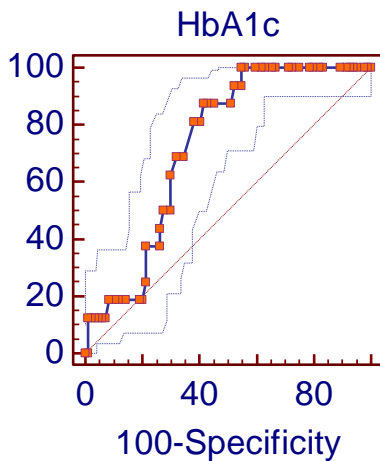


Figure (3): Roc curve analysis of HbA1c level in hypogonadism according to Total testosterone.

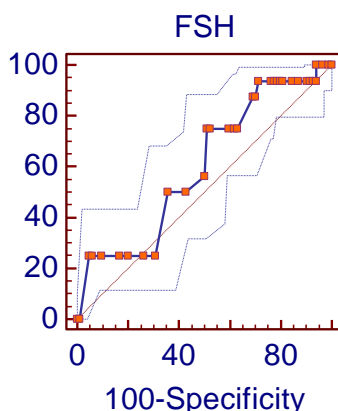


Figure (4): Roc curve analysis of FSH level in hypogonadism according to Total Testosterone

Discussion

Reduced concentrations of serum testosterone and certain clinical characteristics are the characteristics of a medical disorder known as hypogonadism in men, which is a prevalent condition. problems with paying attention to detail, regression of the body and memory loss, disappointment, dysfunction of the erection, in addition to loss of libido are some of the common clinical manifestations of this condition. It has a very negative impact on the QOL of cases [8]. In current years, research has demonstrated that hypogonadism is closely associated with the onset of diabetes [9]. It was established that men cases with T2D have a significantly increased risk of developing hypogonadism. The percentage of diabetic individuals who have reduced total testosterone concentrations is 36.5 percent [10]. Cases with diabetes who suffer from male hypogonadism have a significant decline in their life quality [11,12]. There is an unclear of clarity regarding the nature of the correlations between hypogonadism and diabetes at this time. Because of this, it is of greatest importance to investigate the factors that put people at risk factors for hypogonadism in order to make diagnosis, avoidance, in addition primary management more accessible.

The goal of the present research was to assess the incidence of hypogonadism and the risk factors related to it between cases diagnosed with T2D in the Egyptian population. This was carried out through the utilization of an ADAM questionnaire, which included both total and free testosterone concentrations (\leq twelve nanomole, ≤ 5.7). Based on the total testosterone concentration, we



observed that the incidence of hypogonadism was 24.2 percent, with 56.3 percent of those cases being secondary hypogonadism and 43.7 percent being primary hypogonadism. On the other hand, regarding the free testosterone concentration, we discovered that the incidence of hypogonadism was 42.42 percent, with 2ry hypogonadism accounting for 56.3 percent of the cases and main hypogonadism accounting for 42.9 percent of the cases. The investigation of Dhindsa et al., [13] that has been performed in 103 cases by hypogonadism thirty-three percent in cases aged 28e80 years) and they stated that the elevated incidence could be attributed to a greater mean BMI, had outcomes that were comparable to our own. Additionally, a multicenter investigation that has been carried out in India stated an incidence of hypogonadism of 20.7 percent between cases who had diabetes mellitus [4].

Following the outcomes of our research, we discovered that the incidence of hypogonadism was greater with free testosterone cut of concentration (not more than 5.7 picograms per milliliter) compared to total testosterone (not more than twelve nanomoles per liter). This result is in line with the outcomes of Rhoden et al., [14], a cross-sectiona research conducted in Brazil. Rhoden et al. stated that total and free testosterone concentrations were subnormal in forty-six percent and thirty-four percent of diabetics, correspondingly. Hypogonadotropic hypogonadism was shown to be the most common kind of hypogonadism among the diabetes participants who participated in this clinical investigation. In the research conducted by Chandel et al. [15], it was discovered that the levels of follicle stimulating hormone and luteinizing hormone in cases with type 2 diabetes who had reduced levels of free testosterone were within the normal range. While 43.7 percent of the cases had 1ry hypogonadism, which is defined as LH beyond ten MIU/ML, 56.3 percent had 2ry hypogonadism, which is defined as LH below ten MIU/ML. A study conducted by Tenover and colleagues [16] discovered that the most of hypogonadal males above the age of Sixty had reduce levels of LH or concentrations that were abnormally normal. In contrast to the findings that we obtained, the research conducted by Ali et al. [17] and Kapoor et al. [18] indicated that seven percent of diabetics had hypogonadotropic hypogonadism. Both of these studies observed

that diabetics with reduced serum free and serum total testosterone concentrations had great concentrations of LH and FSH in their serum and urine.

A crucial risk factor for the progress of hypogonadism is age, according to the findings of the current research, which suggests that age is a significant risk factor for the progress of hypogonadism. 1 study found that men among the ages of sixty and seventy years had a higher incidence of low total testosterone, which was found to be sixty-nine percent According to Grossmann et al. [19], who observed that forty-three percent of males of the similar age had reduce total testosterone, this result is in keeping with their findings. There have been a number of investigations that have revealed that the percentage of diabetic males who have a subnormal concentration of total testosterone gradually increases with age [20-22]. An univariant association among total testosterone and age wasn't established in studies that were carried out in New York and South Africa [13,23]. This is despite the fact that we discovered that older age groups had a reduced testosterone concentration than younger age groups. In contrast to this research, an investigation that was carried out in Jordan found that there was a substantial positive association between age and TT [24]. A substantial inverse association among age and TT level was shown to exist, according to research conducted in England and Nigeria [25,26]. The fact that SHBG it's referred to serum hormone binding globulin, that is responsible for sixty to eighty percent of testosterone binding, rises with age is the most probable reason for these inconsistencies. On the other hand, reduced concentrations of SHBG can be present in the presence of insulin resistance, which can lead to a reduction in TT concentrations. Consequently, because the amounts of bioavailable testosterone weren't measured, it is difficult to speculate on the extent to which this confounding factor SHBG impacted our findings, if it did so at all [27]. The current investigation illustrated that there was a statistically significant association among the concentration of HbA1c and the concentration of testosterone in the serum. According to the findings of other studies, this discovery is in agreement with other findings. Kapoor et al. [25], These results additionally contradict the results of the research that has been conducted by Fukui et al., [22]. Fukui et al. discovered that total testosterone levels had a positive correlation with HbA1c



concentrations. That results is in contrast to the outcomes that Dandona et al., [28] and Grossmann et al., [21] discovered.

the current research, we found that serum testosterone concentrations had a negative correlation with blood glucose markers, such as HbA1c values. This result is in agreement with the findings of previous investigation performed by Laaksonen et al. [30], Rabia et al. [29], as well as Fukui et al. [22], which demonstrated that testosterone in the serum concentrations had a negative correlation with glucose indicators. Other markers of resistance of insulin, including as body mass index, waist-to-height ratio, and waist/hip ratio, have additionally been reported to be associated with reduced concentrations of testosterone in men. HbA1c concentrations aren't the only markers of insulin resistance. Insulin resistance has been reported to be connected with decreased serum testosterone concentrations, according to a number of research that have verified this association. Possible explanations include the fact that testosterone regulates the expression of the GLUT-4 gene as well as other genes that play a significant role in insulin signaling. There is a drop in the glycolytic enzyme activity in muscle, abdominal adipose tissues, in addition to liver when testosterone concentrations are decreased [31,32]. This is because reduced testosterone concentrations result in a reduction in the expression of GLUT-4 levels in muscles. Additionally, a decrease in testosterone levels leads to an imbalance in the control of lipid metabolism, and that in effect raises the possibility of developing diabetes [33,34].

Conclusion

In conclusion, hypogonadism is a prevalent yet often overlooked condition among men with type 2 diabetes, with age, poor glycemic control (HbA1c), increased body mass index (BMI), and insulin resistance emerging as significant independent risk factors. Free testosterone measurements were more sensitive in detecting hypogonadism than total testosterone, and hypogonadotropic hypogonadism was the predominant form observed. However, this study has several limitations, including its cross-sectional design, which limits the ability to infer causality, and the absence of measurements for bioavailable testosterone and sex hormone-binding globulin (SHBG), which could have enhanced diagnostic precision. Additionally, the

use of a symptom-based questionnaire (ADAM) may introduce response bias, and the study's focus on a single geographic area may affect the generalizability of the findings. Based on these insights, it is recommended that clinicians incorporate routine screening for hypogonadism in male T2D patients—especially those who are older, obese, or poorly controlled—using both hormonal assays and clinical questionnaires. Future studies should adopt longitudinal designs, assess SHBG and bioavailable testosterone, and include broader, more diverse populations to better understand the causal pathways and therapeutic implications of hypogonadism in diabetic men.

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