Austin Journal of Nutrition and Food sciences

Open Access

Austin Publishing Group

Research Article

Evaluating the Inter Relationship between Obesity and Diabetes Mellitus Type 2: A Clinical Pilot Study

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Received: June 27, 2023

Accepted: July 27, 2023

Published: August 03, 2023

Abstract

Purpose: This study aims to investigate the effect of anthropometric parameters and clinical indexes on a sample of diabetic patients.

Material and Methods: 440 patients with Type 2 diabetes (T2D), with an average age of 49.9 years, who were selected from a sample of 2.500 cases. Entry criteria for the group were the long-term follow-up period of patients and the repeatability of lab tests.

Results: A strong effect was observed between Body Mass Index (BMI) and hyperglycemia. The frequency of T2D occurrence, was higher in overweight patients (>25 kg/m^2) than in those with normal weight (<25 kg/m^2). The mean BMI of newly diagnosed diabetic patients was 30.2 Kg/m^2. There was found a dependence between BMI and sex with the occurrence of cholelithiasis-cholecystitis, with a higher incidence in the class of obese and women. People with normal weight were found to have T2D at a younger age than the other BMI classes that did not differ from each other. Women show higher glucose concentrations than men with normal body weight. At the same BMI class, blood glucose is higher in women than in overweight class. In men no change in glucose was observed at the different BMI classes. The transition of hemoglobin (HbA1c) from step 2 (>7%) to step 1 (<7%) causes a triglyceride concentration reduction of 14.5%. BMI was recorded as the third factor correlated with hyperglycemia, after predisposition and hyperlipidemia and before diastolic blood pressure and age.

Conclusions: At the ascertainment of the newly diagnosed T2D, the presence or not of obesity, determined of BMI, does not affect blood glucose levels in men. In women the normal BMI levels are not deterrent factors of high glucose values, nor age, regardless of gender. BMI is classified as third correlation factor of highglucose values in newly diagnosed diabetics.

Keywords: Diabetes; Obesity; Cholesterol; Triglycerides; Cholelithiasis; Cholecystitis

Introduction

Diabetes Mellitus (T2D) is one of the most common Non-Communicable Diseases (NCDs) [1] and is the fourth most common cause of death among these diseases (for all ages for both sexes) worldwide [2]. The International Foundation of Diabetes (IDF) estimates that 1 in 11 adults has diabetes (425 million) and 1 in 2 adults with diabetes is undiagnosed (212 million). This number is expected to reach 629 million people with diabetes in the World in 2044 [3].

There are various studies in the international literature, regarding dietary standards related to clinical indicators of diabetes [4] with prevalence of obesity [5,6], but also of the classical risk factors, such as predisposition [7], cardiovascular diseases [8], dyslipidemia [9,10], high blood pressure (hypertension) [11]. And age [12] in diabetic population. Over the years, researchers have studied the relationship between T2D and obesity [13, 14], as well as its various parameters, such as obesity during childhood [15] and teenage age [12], and the distribution of adipose tissue [16, 17]. However, there are few reports on the category of normal weight people and their glucose levels during their first visit and the diagnosis of the disease.

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Citation: Pavlidou E, Fasoulas A, Petridis D, Tryfonos C, Giaginis C. Evaluating the Interrelationship between Obesity and Diabetes Mellitus Type 2: A Clinical Pilot Study. Austin J Nutri Food Sci. 2023; 11(1): 1170.

Table 1: Comparison between first and subsequent visit (at least year) as part of recurrent medical examination.

	SYST	DIAS	CHOL	TRIG	HDL	LDL	SGOT	SGPT	URIA	KREAT	HbA¹C
Low before treatment	184	223	56	186	63	34	286	268	237	201	57
Low after treatment	43%	52%	14%	49%	19%	12%	96%	91%	73%	63%	13%
High before treatment	55	52	34	42	38	17	3	8	32	42	3
Low after treatment	13%	12%	9%	11%	11%	6%	1%	3%	10%	13%	8%
High before treatment	82	97	118	63	41	84	5	14	22	24	118
Low after treatment	19%	23%	31%	16%	12%	30%	2%	5%	7%	7%	28%
High before treatment	106	55	176	90	199	148	2	5	32	53	215
High after treatment	25%	13%	46%	24%	58%	52%	1%	1%	10%	17%	51%
N	427	427	384	381	341	283	296	295	323	320	423

Table 2: Association of obesity with cholelithiasis - cholecystitis in patients with TD2.

	BMI				
Cholecystitis-cholelithiasis	**18.5-24,9**	**25-29.9**	**30-34.9**	**35-39,9**	**Total**
No	62	164	108	53	387
Stand. Resid.	0,4	0,2	0,05	-0,8	
Yes	3	13	10	12	38
Stand. Resid.	-1,3	-0,7	-0,2	2,5	
Total	65	177	118	65	425

Table 3: Association of patients' gender with the presence of cholecystitis and cholelithiasis.

Cholecystitis-cholelithiasis	Men	Women	Total
No	215	186	401
Stand. Resid.	0.6	-0.6	
Yes	12	27	39
Stand. Resid.	-1,9	2	
Total	227	213	440

In view of the above considerations, the aim of this study was to prospect all possible effects of BMI on T2D in adults and to examine all relevant factors such as etiology, blood tests and therapeutic interventions both at the first time of the disease diagnosis and during the follow-up period.

Materials and Methods

Study Population

In the context of this research, it was studied, the medical history of 440 patients with type 2 diabetes mellitus with an average age of 49.9 (±13.1) years, 48% women and 52% men with an average disease duration of 11.2 (±8. 8) years.

From demographic-social characteristics, were recorded the sex, age (as of the date of birth), the marital status (married or single), and the profession, which was divided into two categories of physical activity (due to lack of other categories): a) physical activity level (PAL): 1.53 (Sedentary or light activity lifestyle) b) PAL: 1,76 (Active or moderately active lifestyle) (FAO/WHO). The controlled population came from both urban and rural areas.

From the anthropometric characteristics, the present weight, maximum weight and ideal weight were recorded.

From the medical history, was recorded, the time of onset of the disease, the blood pressure (systolic and diastolic), the presence of heart disease, hyperlipidemia (increases in both Cholesterol (Chol.) and Triglycerides (TGs), diabetic angiopathy, cholelithiasis and cholecystitis. In addition, the numbers of births and miscarriages were recorded in women. Also, the family predisposition for T2D (FHD) was recorded, which was divided into 3 categories (none, one and two relatives of first degree, e.g. parent or brother).

Also, the causes that led to the diagnosis of the disease, including: Incidental finding of disease, polyuria, polydipsia, weight loss, acidosis and hyperglycemic and hypoglycemic coma, were also recorded.

From hematological and biochemical laboratory parameters, was recorded, the blood glucose, total Chol., LDL (chol.), HDL (chol.), TGs, urea, uric acid, Haemoglobin (HbA1c), SGOT, SGPT. All of the aforementioned blood tests were performed in the same hospital laboratory, where patients were coming for their planned and systematic medical examination.

Ethics and Morality

The study was conducted according to the guidelines of the international ethical standard of scientific quality for the design, conduct, performance, recording, analyses, and reporting of clinical trials. The ethics of the study protocol was approved by the local committee.

Diagnostic Criteria

In the present study the following diagnostic criteria were used:

For T2D: fasting blood glucose >126 mg/dL and / or 2-hour glucose levels ≥200 mg/dL, [18] and / or antidiabetic treatment.

For hypercholesterolemia: Total cholesterol >200 mg/dL (Borderline high: 200 to 239 mg/dL) and / or LDL cholesterol >130 mg/dL, and / or Triglycerides: -high: 150 to 199 mg/dL) [19-21] and / or lipid-lowering treatment.

For hypertension: Systolic blood pressure >140 mmHg and / or Diastolic blood pressure >90 mmHg [22,23] and / or antihypertensive treatment.

Statistical Analysis

Continuous variables with normal distribution are presented as mean ± Standard Deviation (SD), while the categorical variables are presented as absolute and relative frequencies (%). Student's analysis was used to evaluate the correlations between categorical and continuous variables following the normal distribution. The statistical control of the significance of the incidence of the disease was done by Chi-square test. The Estimation of the likelihood of occurrence of T2D depending on the parameters of the occurrence of other conditions and symptoms were made based on the calculation of the relative ratios and the corresponding 95% confidence intervals by logarithmic regression analysis. All the values presented are compared to the statistical significance level of 5%. For the calculations, the MINITAB.18 package software was used.

Results

As revealed by the study, the percentage of men and women

is almost the same (5.2: 4.8, respectively), most are married (9: 10), with a generally sedentary lifestyle with PAL: 1.53 & PAL: 1.76, in a ratio of 5.2: 4.8 and absence of other categories of greater physical activity.

The 83.5% of this population, upon the first visit and diagnosis of the disease is classified as overweight (BMI >25). In men, 51% belongs to the pre-obesity class (BMI: 25-29.9) and 31% in obesity class (BMI >30), 82% overall. In women, 24% belongs to pre-obesity class and 61% in obesity class (85% overall).

The Family History Diabetes (FHD) (none, one or both of the first-degree relatives) with a ratio of 2.6: 4.3: 3.1 (respectively), seems to predominate. Thus, the final ratio between those who have FHD and those who have not, is 7.4: 2.4.

As major cause of diagnosis of T2D was recorded the incidental finding (56%) and is followed by classic symptoms such as polydipsia (20%), polyuria (13%), and weight loss (7%).

In the medical history during the first visit and diagnosis, increased rates of cardiovascular disease (56%) and diabetic angiopathy (42%) are observed. Also, a significant percentage (62%) shows increased systolic pressure and diastolic pressure (44%). Table 1 presents the comparative analysis of various parameters (such as systolic and diastolic pressure), lipids (cholesterol, triglycerides, HDL, LDL), SGOT, SGPT, Urea, Creatinine, and HbA1c, during the first visit and at one of the subsequent post-treatment visits (at least one year) as part of the repeat check-up at the hospital.

Listed below are some of the parameters shown in Table 1.

Systolic Pressure: With treatment, 43% remained normal, 19% improved, 13% worsened, and 25% remained at abnormal levels.

HbA1C: With treatment, 30% improved, 13% remained at normal levels, 8% worsened, while 51% remained abnormal levels.

HDL-LDL-HbA1c: Continuously significant negative result with respect to overall treatment, above 50% (58%, 53% & 51%, respectively).

The transition of HbA1c from Stage 2 (>7%) to Stage 1 (<7%) causes a decrease in the triglyceride concentration by 14.52% (p=0.000), one-way ANOVA. This finding did not take into account the possible involvement of the hypolipidemic treatment as no relevant separation was made.

Table 2 shows that obese class II patients with TD2 exhibit a higher incidence of Cholelithiasis - Cholecystitis compared to the other BMI classes.

Table 3 shows that women are more susceptible to cholecystitis (occurring more often), while men rarely develop the disease.

Women show higher glucose concentrations than men, while no change in glucose is seen in FHD subjects (Figure 1).

Women show higher glucose concentrations than men with normal body weight (BMI 18.5-24.9). At the same class of BMI (normal-weight), glucose is higher in women than in other classes (pre-obesity and obesity). No change in glucose is observed in men at the different BMI classes (Figure 2).

There is a strong positive influence between (a) glucose - HbA1c - predisposition - cholesterol, (b) triglycerides - BMI and (c) age - systolic pressure (Figure 3).

Patients with randomly finding of T2D and elevated glucose levels, occur at a higher incidence than patients with symptomatology (Figure 4).

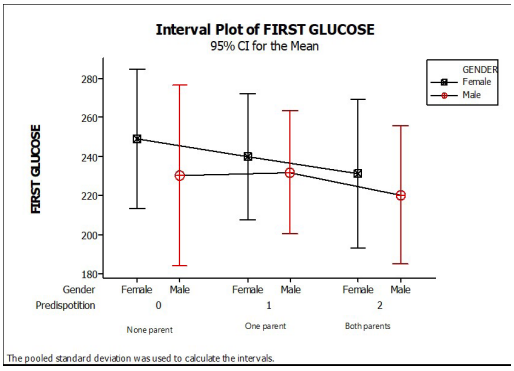

Figure 1: Glucose levels according to patient's gender.

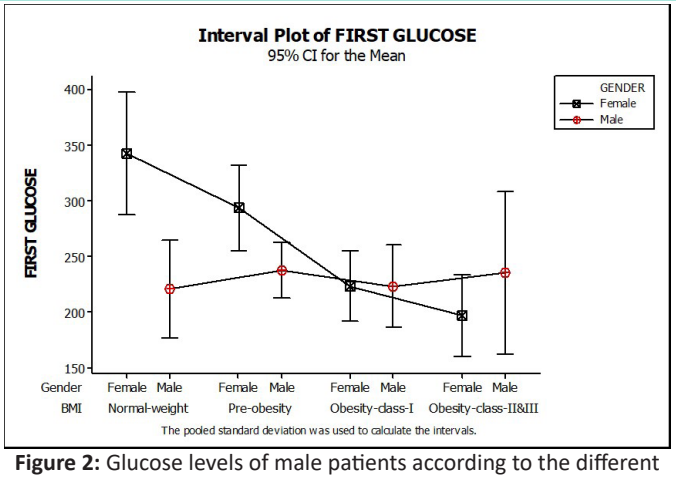

Figure 2: Glucose levels of male patients according to the different BMI classes.

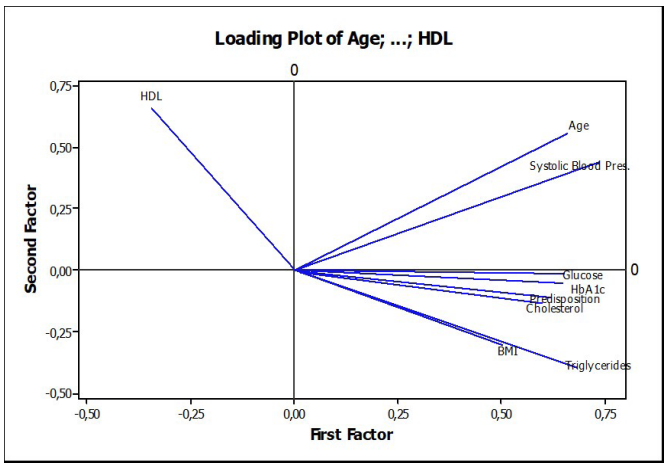

Figure 3: The associations amongst (a) glucose - HbA1c - predisposition - cholesterol, (b) triglycerides - BMI and (c) age - systolic pressure.

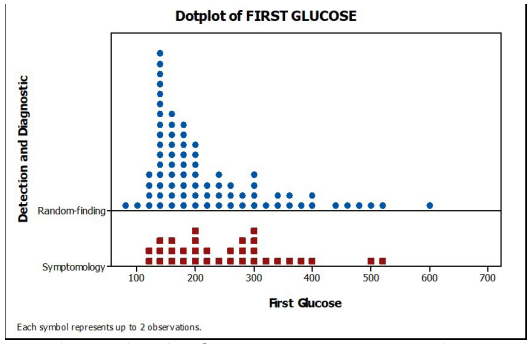

Figure 4: Glucose levels of patients in association the presence of symptomatology.

Discussion

The present clinical study is important as the data presented a) provide important new information on the particularly elevated glucose levels in the normal-weight class and especially the women, b) supply information on the highest risk of Cholelithiasis - Cholecystitis in people with T2D, who are in the obesity class II and especially in women, c) provide information on various clinical parameters both during the diagnosis and during disease progression, d) can be used to detect differences between BMI classes in patients with T2D, e) and also can be used by health professionals for further research and reference. More specifically, our study suggests the following, in relation to the factors investigated

Physical inactivity: At diagnosis of T2D, it was found that all of the individuals reported sedentary life and lack of intense physical work or exercise (sports). This finding consents with previous studies that indicate that glucose levels and obesity are associated with physical inactivity [24, 25].

Family History Diabetes (FHD): This study verifies the strong effect of family history on the onset of the disease, with 7 out of 10 newly diagnosed patients having hereditary predisposition by one or both first degree relatives, but without exercising influence over glucose level. This finding agrees with other studies that indicate that FHD contributes to the increased risk of T2DM [25-27].

Hyperlipidemia: Hyperlipidemia in the present study is presented as the second strongest factor associated with elevated glucose values (with cholesterol playing a stronger influence than triglycerides). This finding is also confirmed by other studies suggesting that there is a two-way relationship between hyperlipidemia and diabetes [28, 29].

BMI: The finding of the present study, which concerns the relationship between BMI and T2D, is not surprising, but it is interesting to see its ranking. BMI appears to be the third most important factor after FHD and hyperlipidemia (including cholesterol and triglycerides). According to the same findings of our study, it appears that eight out of ten newly diagnosed diabetics belong to the pre-obesity and obesity class, with women taking the lead in obesity and men in the pre-obesity class. It is known from studies that both genetic and environmental factors, such as obesity and aging, play a key role in the onset of the disease [25,30,31].

Undiagnosed diabetes: The findings of our study showed that in six out of ten patients, diagnosis of T2D is a random finding. This result corroborates previous studies and reports that indicate that a significant proportion of people found to have diabetes were not previously diagnosed [32], possibly due to the lack of symptoms associated with the early years of T2D [3]. Furthermore, the findings of our study showed that people with undiagnosed diabetes had already experienced retinopathy & neuropathy.

Cholecystitis-cholelithiasis: An important finding of our study concerns the greater prevalence of Cholelithiasis - Cholecystitis, in class II obese patients with T2D and especially in women. Diabetes is considered one of the factors that may cause the development of biliary disorders [33]. Cholelithiasis is associated with several risk factors such as diabetes, high body mass index, female gender, aging, genetic predisposition, alcohol abuse, high triglyceride and cholesterol concentration etc. [34].

One of the interesting findings of our study regards the relationship between Hyperglycemia, BMI and Gender. More specific, higher glucose levels were found in normal-weight women. Occasionally, studies suggest that there may be approximately 500 subsets of diabetic patients, depending on their different environmental and genetic characteristics [35]. Besides, there are studies that refer to five T2D categorization groups, including young people with a healthy weight [28,31,35].

Some of the expected findings of our study also indicate the followings:

Cardiovascular disease: In our study, it appears that more than half of patients with undiagnosed T2D have already had cardiovascular disease and hypertension. It is scientifically documented that cardiovascular disease is one of the serious complications of TD2 [36] and nearly two out of three patients who have symptomatic chronic heart disease have abnormal glucose homeostasis [37]. Also, T2D is associated with an increased risk of hypertension [38].

Diabetic angiopathy: Our study found that nearly four out of ten patients with undiagnosed T2D already have a form of angiopathy associated with diabetic complications. It is known that undiagnosed diabetes can cause continuous hyperglycemia and consequent irreversible lesions in various tissues and mainly in the retina, blood vessels, neural tissue and kidney glomeruli [39].

Diabetic retinopathy (DR): The results of this study indicate that more than one in ten patients with undiagnosed T2D already has diabetic retinopathy (DR) (one of the microvascular complications). This complication is the main cause of vision loss in adults of working age [40].

Conclusion

During the first visit, in patients with newly diagnosed T2D, the BMI does not affect blood glucose levels in men. In women the normal levels of BMI, systolic and diastolic pressure is not deterrent factors of high glucose levels, but neither the age regardless of gender. According to this study, BMI is ranked as the third most important factor of high glucose values in newly diagnosed diabetics, after FHD and dyslipidemia and before high blood pressure (hypertension) and age. An important factor in detecting the disease, is a symptomatology with polidipsia being the main symptom, accompanied by higher glucose levels, which are also found in patients with FHD (2 parents) and, also with incidental finding of TD2. The main risk factor for cholecystic disease in diabetic population is mainly gender (female) and the age. Obesity (which is a modifiable factor) has an important role, making the appropriate healthy-eating plan indispensable both during the prevention and the outbreak and control of the disease.

Author Statements

Authors' Contribution

Pavlidou E. and, Petridis D. were responsible for data collection and data analysis. Pavlidou E., Fasoulas A., Petridis D., Tryfonos C., and Giaginis C. were responsible for study design, draft report writing and critical revisions. All authors have read and approved the final article

Funding

This research did not receive any specific grant from funding

agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors have no conflict of interest to declare.

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