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Original article

A Study of Obese and Non-Obese University Students' Blood Glucose Levels in Tripoli, Libya

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In Libya, obesity and its associated conditions, such as diabetes, are serious health issues. Early identification of those who are obese may reduce the risk of developing T2DM. Thus, this study aimed to compare measurements of fasting blood glucose (FBS) and glycated hemoglobin (HbA1c) levels in obese or overweight and non-obese University of Tripoli students. The study included 53 obese and overweight students with a BMI greater than 25 kg/m2 and 64 non-obese who had a BMI less than 25 kg/m2. To measure the level of FBS and HbA1c, 4 ml of venous blood was drawn from each subject in the University Infirmary. The samples were transferred to the Tajoura Alwasat laboratory, and both the plasma blood level and HbA1c were measured using an automatic device, COBAS INTEGRA 400 plus. There were no significant differences obtained in blood glucose either in FBS or in HbA1c levels between obese or overweight and non-obese students ($p>0.05$). However, a strong positive correlation was obtained between HbA1c levels for both waist circumference and waist/hip ratio in the obese or overweight group [$r=0.322$, $P=0.023$] and [$r=0.316$, $P=0.025$], respectively. The incidence of T2DM might be diminished by encouraging young adults to keep both waist circumference and waist/hip ratio in the normal range.

Introduction

Obesity and type 2 diabetes mellitus (T2DM) have a serious impact on the health of populations around the world. Several factors are known to increase the likelihood of developing diabetes mellitus, even if the precise causes of the disease are still not entirely clear. However, T2DM and obesity are closely related conditions, and the sharp rise in T2DM incidence and prevalence over the previous 20 years can be largely attributed to the global obesity pandemic (1).

Body mass index (BMI) is used to evaluate nutritional status and body fat proportion (2,3). Being overweight is defined by the World Health Organization (WHO) as having excessive adiposity, while obesity is a chronic complex disease that impairs health and is characterized by even higher excessive adiposity (4). Overweight and obesity are caused by having a higher energy intake than that expended (energy surplus) and this can be compounded by a range of other factors, including genetics and lifestyle (5).

It was reported in 2014 that as many as 1.9 billion people, aged 18 and over, were overweight, and 600 million were found to be obese. By 2022, the situation had worsened, with 43% of adults aged 18 years and over being overweight and 16% being obese (6). Obese people have a seven times higher risk of diabetes than people of a healthy weight, and those who are overweight have a three times higher risk (7).

Obesity is associated with poor lifestyle choices, including sedentary behavior, decreased physical activity, poor diet, alcohol, and sleep deprivation, especially among college students, who comprise a sizable share of the young adult population(8–10). Undergraduate students' eating habits (emotionally motivated, uncontrolled, and fast-food consumption) combined with a higher incidence of depression further exacerbate this problem. Higher rates of obesity as a result of all these habits are particularly prevalent among female university students (11).

Recently, a study of 246 Libyan university students in Tripoli revealed that 54% of them had a normal body mass index (BMI). Of both sexes, 38% of the students were obese or overweight. The distribution of BMI was less than 18.5 kg/m^2 (8%), normal 18.5–24.9 kg/m^2 (54%), overweight 25–29.9 kg/m^2 (23%), and obese up to 30 kg/m^2 (15%) (12).

More research on young Libyan students, using representative sampling, would be beneficial to better understand the prevalence and influence of excess weight in this particular group. This information will be instrumental in developing strategies to counteract the obesity epidemic, which is helping to drive up the prevalence of T2DM in the wider general population (13,14). However, no studies comparing the blood glucose levels of obese and non-obese students have been carried out on Libyan students to date. Therefore, the purpose of this study was to compare measurements of fasting blood glucose (FBS) and glycated hemoglobin (HbA1c) levels in obese and non-obese University of Tripoli students.

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Methods

Study design and setting

In total, 118 university students participated in this study. One student was excluded because they had diabetes, so the final sample consisted of 117 students. Recruitment was conducted from November 24 to December 19, 2024, at the University Infirmary. The study included 53 cases, apparently healthy, obese, and overweight students with a BMI greater than 25 kg/m^2 and 64 controls who had a BMI less than 25 kg/m^2. Students diagnosed with diabetes mellitus were excluded. The inclusion criteria of subjects in this study were that they were Libyan, in the age group 18 to 30 years, and students registered at Tripoli University.

Data and sample collection

The questionnaire used covered a range of topics, including age, gender and diabetes status. To complete the questionnaire, students provided anthropometric measurements, including height (to the nearest 0.1 cm without shoes) and body weight (measured with electronic scales to the nearest 0.01 kg). Height and weight were then used to determine body mass index BMI (weight kg/height m^2). Waist and hip circumferences were measured with a non-extendable tape measure placed horizontally, just above the iliac crest. Finally, the waist-to-hip ratio was calculated by dividing the waist circumference by the hip circumference.

To measure the level of blood glucose and HbA1c, 4 ml of venous blood was drawn from each subject in the University Infirmary, and 2 ml of venous blood was placed in a sodium fluoride tube and 2 ml in an EDTA tube. The samples were transferred to Tajoura Alwasat laboratory, and the plasma blood level and HbA1c were measured by an automatic device, COBAS INTEGRA 400 plus.

Results

Of the total number of students included in this study, 117, 64 (54.7%) were nonobese and 53 (45.3%) were obese or overweight students. The breakdown of BMI for males and females, respectively, were underweight < 18.5 kg/m^2 (2.5% and 12%), normal 18.5–24.9 kg/m^2 (5.1% and 35%), overweight 25–29.9 kg/m^2 (2.6% and 11.1%), and obese ≥ to 30 kg/m^2 (1.7% and 29.9%) as shown in Table 1.

Table 1. The numbers and percentage of students, male and female, in this study are according to their BMI categories.

BMI (kg/m^2)		Gender		Total
		Male	Female	
Under 18.5	Count	3	14	17
	%	2.5%	12.0%	14.5%
18.5 to 24.9	Count	6	41	47
	%	5.1%	35.0%	40.2%
25 to 29.9	Count	3	13	16
	%	2.6%	11.1%	13.7%
30 or more	Count	2	35	37
	%	1.7%	29.9%	31.6%
Total	Count	14	103	117
	%	12.0%	88.0%	100.0%

Table 2 shows comparisons in various parameters between non-obese students (64) and the obese or overweight students (53). The mean values of weight, BMI, waist circumference, and hip circumference were significantly higher in the obese or overweight students compared with the non-obese students. Statistically significant differences between the obese or overweight and non-obese students were observed in these four parameters. Whereas height and waist hip ratio were almost the same between the two groups, thus, no significant differences were obtained between the two cohorts (p=0.866, p=0.361) respectively. The mean FBS level was 93.25±14.13 mg/dl in non-obese students and 94.17±12.89 mg/dl in obese or overweight students. The difference between the mean FBS between both groups was statistically insignificant with p p-value of 0.714. The mean HbA1c level was 5.19±0.46% in non-obese students and 5.07±0.39% in obese or overweight students. The difference between mean HbA1c levels between both groups was statistically insignificant, with a p-value of 0.144.

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Table 2. Mean values of weight, standing height, BMI, waist circumference, hip circumference, waist: hip ratio, FBS level, and HbA1c. There was a significant result (p<0.05) in weight, BMI, waist circumference, and hip circumference.

parameters	Non-obese (N=64)	Obese or overweight (N=53)	p-value
	Mean± SD	Mean± SD	
Weight in kg	54.80±7.77	83.52±10.55	0.000**
Standing Height in meters	1.6316±0.07	1.6338±0.07	0.866
BMI kg/m^2	20.52±2.50	31.28±4.05	0.000**
Waist circumference in cm	70.36±10.34	83.49±16.85	0.000**
Hip circumference in cm	90.05±11.84	105.38±19.48	0.000**
Waist/hip ratio	0.78±0.06	0.79±0.07	0.361
FBS mg/dl	93.25±14.13	94.17±12.89	0.714
HbA1c%	5.19±0.46	5.07±0.39	0.144

The Pearson correlation test showed that the level of HbA1c increased with increasing waist circumference and waist/hip ratio in the obese or overweight group. This positive correlation was statistically significant [r= 0.322, P= 0.023] and [r=0.316, p=0.025] respectively, as shown in Table 3.

Table 3. Correlation of HbA1c with some parameters in overweight and obese subjects.

Variables	R value	P- value
Weight in kg	0.012	0.932
Standing Height in meters	-0.141	0.330
BMI kg/m^2	0.129	0.373
Waist circumference in cm	0.322	0.023*
Hip circumference in cm	0.200	0.163
Waist/hip ratio	0.316	0.025*

The data in Table 4 illustrate the correlation between FBS levels and various parameters in obese or overweight students. No significant correlation was obtained between FBS levels and any of the six parameters weight (r = -0.117, p = 0.406), Length (r = -0.047, p = 0.740), BMI (r = -0.083, p = 0.555), waist circumference (r = 0.123, p = 0.379), hip circumference (r=0.043, p=0.758) and waist/hip ratio (r=0.164, p=0.242).

Table 4. Correlation of FBS level with some parameters in overweight and obese subjects

Variables	R value	P- value
Weight in kg	-0.117	0.406
Standing Height in meters	-0.047	0.740
BMI kg/m^2	-0.083	0.555
Waist circumference in cm	0.123	0.379
Hip circumference in cm	0.043	0.758
waist/hip ratio	0.164	0.242

Discussion

Obesity and its related diseases, like diabetes, are major health problems in Libya. Recent research in Tripoli, Libya (2024) found that 46.7% of Libyan T2DM patients were obese (15). Another study, also conducted in Tripoli, Libya in the same year, compared T2DM patients and controls and found that the average weight of T2DM patients (83.4 kg) was significantly higher than the mean of controls (76.8 kg) with a p< 0.001(16). All these studies highlight the prevalence of obesity among Libyan T2DM patients. In addition, a study carried out at the University of Tripoli indicated a high prevalence of obesity (15%) in young healthy university students (12). This current study in Libya found that an even higher percentage (31.6%) of healthy students, aged between 18 and 30 years, were obese. Although both studies were carried out at the University of Tripoli on healthy students, they focused on different faculties, with higher numbers of female participants in the present study.

It has been suggested in previous research (17) that obese individuals have elevated blood sugar levels and chronic related conditions like diabetes mellitus. In particular, it is proposed that lipid build-up in obese

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subjects results in insulin resistance and raises FBS levels and HbA1c. To investigate this further, in Libyan students, this study compared the FBS and HbA1c levels of obese or overweight and non-obese students. This present study, in Libyan university students, showed that obese or overweight subjects did not have higher FBS or HbA1c levels compared to non-obese students. Similar findings were obtained from a study that compared HbA1c and FBS levels between obese and non-obese individuals with polycystic ovary syndrome (PCOS), where no significant difference was found (18). The agreement between these results, from both studies, could be because this current study had a particularly high percentage (88%) of female students in the cohort.

Chaudhari et al found an association between both blood glucose and HbA1c with BMI in obese medical students (17) however, this current study did not find any such correlation in these levels with BMI in obese or overweight Libyan students. On the other hand, in Libyan students, a positive correlation was found between HbA1c and both waist circumference and waist/hip ratio. This would indicate that monitoring of these two simple physical measurements could help identify those with raised glucose levels and allow for earlier identification and intervention strategies for those most susceptible to developing T2DM.

This present study in Tripoli, Libya, however, found no significant association between FBS and BMI (r=-0.083, p=0.555) in overweight and obese students. Similar findings were obtained from previous research conducted at the University of Tripoli (12) and also within a study conducted in Ayub Medical College, Abbottabad, Pakistan (r=101, p=0.214) (19). In these three studies, there was no correlation found between FBS levels and BMI; however, in contrast to this, a study in an upstate New York college reported a positive correlation (20). Ethnicity can also influence the association between diabetes mellitus and obesity, and may explain the different levels of association found between the blood glucose levels and obesity observed in different populations (21).

The current study's strengths in Libya include the range of data gathered, such as survey data, anthropometric measurements, blood glucose, and HbA1c monitoring to assess the risk of T2DM. The fact that there were more female than male participants was one of the study's drawbacks. A more balanced gender mix would have helped focus on gender-related risk factors for type 2 diabetes. However, the majority of students in every faculty at the University of Tripoli are female, making this balance harder to achieve. This was compounded by male students being generally more reluctant than females to participate in such studies.

Conclusion

There were no significant differences found between obese or overweight students and non-obese in blood glucose levels by using either FBS or HbA1c. Evaluation of waist circumference and waist/hip ratio may help the clinician to identify those who have elevated HbA1c levels earlier and prevent the disease from developing at a later stage. A proper, balanced diet along with exercise is essential in avoiding obesity. Health initiatives at the university, such as educational interventions, could help promote awareness about obesity and its related diseases, such as T2DM.

Conflict of interest. Nil

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الملخص

في ليبيا، تُعدّ السمنة والحالات المرتبطة بها، مثل داء السكري، مشاكل صحية خطيرة. قد يُقلّل الاكتشاف المبكر للمصابين بالسمنة من خطر الإصابة بمرض السكري من النوع الثاني. لذا، هدفت هذه الدراسة إلى مقارنة قياسات مستويات سكر الدم الصائم (FBS) والهيموغلوبين السكري (HbA1c) لدى طلاب جامعة طرابلس الذين يعانون من السمنة أو زيادة الوزن وغير البدناء. شملت الدراسة 53 طالبًا يعانون من السمنة وزيادة الوزن بمؤشر كتلة جسم أكبر من 25 كجم/م2 و64 طالبًا غير بدناء بمؤشر كتلة جسم أقل من 25 كجم/م2. لقياس مستوى FBSوHbA1c، تم سحب 4 مل من الدم الوريدي من كل طالب في مستوصف الجامعة. نُقلت العينات إلى مختبر تاجوراء الوسط، وتم قياس كل من مستوى بلازما الدم و HbA1cباستخدام جهاز أوتوماتيكي، وهو جهاز COBAS INTEGRA 400 plus. لم تُلاحظ فروق جوهرية في مستوى سكر الدم، سواءً في مستوى سكر الدم عند الولادة أو في مستويات الهيموغلوبين السكري (HbA1c) بين الطلاب البدينين أو ذوي الوزن الزائد وغير البدينين (p>0.05). ومع ذلك، وُجد ارتباط إيجابي قوي بين مستويات الهيموغلوبين السكري (HbA1c) لكلٍّ من محيط الخصر ـ ونسبة الخصر ـ إلى الورك في مجموعة البدينين أو ذوي الوزن الزائد [r=0.322, P=0.023] و[r=0.316, P=0.025]، على التوالي. ويمكن الحد من الإصابة بمرض السكري من النوع الثاني بتشجيع الشباب على الحفاظ على محيط الخصر ـ ونسبة الخصر ـ إلى الورك ضمن النطاق الطبيعي.

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