Open Access Research Journal of
Multidisciplinary Studies
Journals home page: https://oarjpublication/journals/oarjms/
ISSN: 2783-0268 (Online)

OARJ OPEN ACCESS RESEARCH JOURNALS

(RESEARCH ARTICLE)

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Body Mass Index (BMI) correlate with blood glucose level in the state of Qatar

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Open Access Research Journal of Multidisciplinary Studies, 2021, 02(01), 005–012

Publication history: Received on 23 August 2021; revised on 30 September 2021; accepted on 02 October 2021

Article DOI: https://doi.org/10.53022/oarjms.2021.2.1.0040

Abstract

Objectives: Development of type 2 diabetes mellites (T2DM) is highly corelated to obesity. This is a cross-sectional study conducted in the state of Qatar to investigate the association between blood sugar level and body mass index (BMI).

Methods: Two-hundred and nineteen adult subjects, undiagnosed with T2DM (defined by ICD-9-CM diagnosis codes and not on anti-diabetic medications) participated in the study. Age ranged from 18-65 with a mean of 42.0 ± 9.8 years (34.0 + 8.6 among females and 44.2 ± 9.6 among males). Blood sugar, weight, height, and BMI were measured during the survey. Individuals with BMI < 18.5 kg/m2 were excluded, (Mean BMI =27.4 ±4.71). Blood sugar level of overweight: BMI 25–29.9 kg/m2 or Obese: BMI ≥30 kg/m2 compared with normal BMI (18.5–24.9 kg/m2) to assess the impact of BMI on blood sugar. Results: 219 participants included in this study, a positive association between BMI with blood sugar level and the risk of a T2DM diagnosis was noticed.

Conclusions: Blood sugar level and the risk of being diagnosed with T2DM is highly dependent and corelated with BMI. The incremental association of BMI category on the risk of T2DM is stronger for people with a higher BMI relative to people with a lower BMI.

Keywords: Obesity; Type 2 diabetes; Body mass index (BMI); Blood Glucose Level (BGL)

1. Background

Increased mortality risk and significant long-term morbidity may accompany with Diabetes as one of the most common metabolic disorder [1- 4]. The majority of diabetes mellitus, approximately (90% – 95%) of all diabetes cases [5,6], belongs to (T2DM), steadily increasing of its prevalence has been noticed [7], and expected to be double by the year 2030 [8]. In the Middle East, a high prevalence of T2DM was reported, because of rapid economic development, urbanization, and lifestyle patterns changes [9]. For prevention as well as lowering T2DM health burden, risk factors identification of T2DM is an essential step to avoid acute complications and to minimize the risk of chronic complications, continuous health care, and self-management, health education, and reliable psychosocial support are needed [10]. Overweight and obesity have become a major worldwide epidemic affecting more than 937 million adults and the figure has almost doubled in number compared to the past 20 years [11]. In the US obesity has become a major public health problem affecting over one-third (35.7%) of the population [12] and is known as a predictor of T2DM [13]. World Health Organization criteria classified BMI (kg/m2) into normal weight (BMI 18.5 and 24.49); overweight (BMI 25 and 29.99); and obese (BMI ≥30) [14].

Excess body weight, whether in people who are overweight (BMI of 25- 29.9 kg/m^2) or obese (BMI ≥ 30 kg/m^2) is increasingly recognized as an important risk factor for many life-threatening diseases including diabetes, hypertension, cardiovascular disease, and some common cancers [15-16]. In *Gulf Cooperation Council Countries* (GCC) particularly in

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Qatar and across the world obesity is a leading public health challenge. Central obesity with modest overweight makes GCC peoples at high risk to develop diabetes, as per a report by Kelly et al. 2005 [17].

Developing various diseases, particularly T2DM is also strongly associated with Physical inactivity [18-28]. The term "diabesity" was proposed by Astrup and Finer in 2000 [29] to describe that excess weight is an important predictor of type 2 diabetes. The worldwide dual epidemic of diabesity is an important public health issue. By 2040, the number of adults with obesity is estimated to be increased sixfold and the number of individuals with diabetes will increased to 642 million. Fatty acids that constitute body fat content may result from high glucose level, an increase in blood glucose level will result in an increase in BMI causing increased lipid biosynthesis and hence body weight [30]. Insulin acts through specific cell receptor of insulin sensitive cells which result in enhanced glucose uptake into the cell [31]. Insulin is an anabolic hormone result in energy conservation and thereby signaling the body to produce fat. As BMI increases, insulin resistance also increases which results in increased blood glucose levels (BGL) in the body. Lipid biosynthesis (lipogenesis) is increased as an increase in (BGL) and hence, an increase in weight [32], as well, it has been established that simple carbohydrates such as glucose can be converted to fatty acids which constitute the body fat contents. Several observations were expected as obesity is known to induce insulin resistance due to a decrease in insulin-sensitive receptors as the weight increases [33]. Adipocytes secrete several biological products (leptin, TNF-alfa, free fatty acids, and adiponectin) that modulate insulin secretion, insulin action, and body weight and may contribute to insulin resistance [34].

"Globesity" – global epidemic obesity is rapidly becoming a major public health problem worldwide. The average BMI has been rising by a few percent per decade in many populations, thus fueling the concern about the effects of increased adiposity on health [35]. Several studies have reported a strong association between excess weight and increased risk of death, placing the overweight group and the obese group at a 40% and up to 300% respectively higher risk of death than individuals whose BMI is normal ($18.5 \leq BMI < 25$) [36-38]. BMI and fasting blood sugar (FBS) levels are positively correlated. As BMI increases, insulin resistance also increases which results in increased blood glucose levels (BGL) in the body. Since BMI is proportional to weight from its standard formula; weight (kg)/ height (m^2), it is therefore expected that factors such as blood glucose which influence weight will ultimately affect BMI. Latest studies have recognized the correlation between body mass index and T2DM in-clouding pro-inflammatory cytokines (tumor necrosis factor and interleukin-6), insulin resistance, deranged fatty acid metabolism, and cellular processes such as mitochondrial dysfunction and endoplasmic reticulum stress [39]. On the other hand, obesity is one of the most important modifiable risk factors in the pathogenesis of health disorders such as atherosclerosis and T2DM reported in most biochemical researches and cross-sectional studies. Since body weight is associated with BMI, it may be expected that BMI should correlate with BGL. In Gulf countries including Qatar, and across the world, obesity is the leading public health challenge. The incidence and prevalence of diabetes in Qatar increasing due to rapid dietary habits and lifestyle changes. In view of the above, the aim of this study is to evaluate the association between blood glucose level and BMI in an adult healthy population in the state of Qatar. Our hypothesis is that excess weight is associated with an increased risk of elevation of blood sugar and T2DM.

2. Material and methods

This cross section-study had been carried out at AL-Khor hospital – Hamad Medical Corporation, normal healthy individuals attending the hospital for routine health check-up were included in the study. The purposes of the medical health checkup program were to promote the health of individual through regular health checkups and to detect diseases at an early stage. The sample included 219 subjects, comprising of 201 males and 18 females, the participant's age ranged from 18-65 years. After obtaining the informed consent, the age, sex, random blood sugar (RBS), height, and weight of the subjects were measured. Weight was recorded to nearest 0.5 kg. Height was measured in a standard standing position without shoes by using a meter scale bar attached to an electronic weighing scale, while keeping shoulders in an erect position to the nearest 0.5 cm, random blood sugar was taken using a glucometer. BMI (kg/m^2) was calculated for each subject using the standard formula; weight in (kg)/height in squared meter (m^2).

2.1. Inclusion Criteria

An adult between 18-65 years and no antidiabetic drugs, BMI ≥ 18.5 kg/m^2.

2.2. Exclusion Criteria

Exclusion criteria included invalid blood glucose tests, absent weight and height information, pregnancy, and/or patients suffering from chronic diseases. All the variables including age, height, weight, BMI, RBS, and family history of diabetes from the study group were organized and analyzed statistically using the SPSS computer program.

2.3. Statistical Analysis

Pearson's correlation coefficient was used to find the correlation between RBS and BMI. The student's t-test was used to check the statistical significance of the changes in BMI and RBS and the level of significance was set at (P≤0.05).

Informed consent was sought and obtained from the subjects and the study was approved by the hospital quality and ethics committee. To date, no article has reviewed the relationship between BMI and RBS in the state of Qatar.

3. Results and discussion

Analysis of two hundred and nineteen (219) subjects' data was carried on and the achieved results are presented in Tables 1. Out of total patients, 91.8% were males, and 8.2% females (11:1 male to female ratio). 32.7% of patients were diabetic, and 67.3% of patients were non - diabetic. 40.6% patients were found to have normal BMI (18.5-24.9 kg/m^2), 34.7% patients were overweight BMI (25.0 - 29.9) kg/m^2, and 24.7% patients were obese BMI≥30 kg/m^2. The risk of developing T2DM at BMI ≥ 30 relative to persons with normal BMI was higher compared to individuals with a normal BMI. Similar pattern displayed by using the relative risks the relative risk was 1.5 (95% CI: 1.4–1.6) for overweight adults and 2.5 (2.3–2.6) for obese adults.

Table 1 General Characteristics Data of Participants

	n	**(%)**
Gender		
Male	201	91.8
Female	18	8.2
Age (years)		
< 40 years	48	22.0
≥ 40 years	171	78.0
Diabetes mellitus		
Diabetic	72	32.7
Non-diabetic	147	67.3
Body mass index (BMI kg/m^2)		
Normal 18.5 - <24.9	89	40.6
Overweight 25 – 29.9	76	34.7
Obese ≥ 30.0	54	24.7

Our study found a steady relationship between BMI and blood glucose level. The statistical difference between BMI groups (normal, overweight, Obese) and RBS was highly significant (p=0.0001) figure 1.

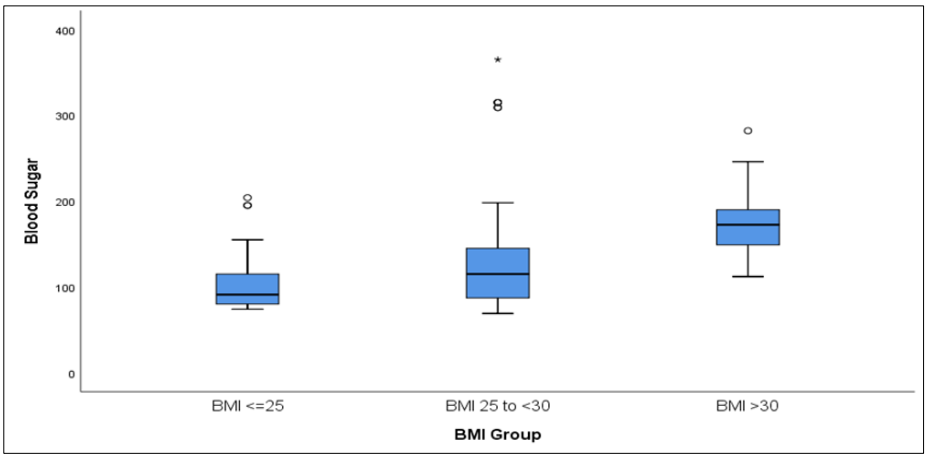

Figure 1 Relationship Between Body Mass Index (BMI kg/m$^{2)}$ and Blood Sugar

The results of the current study showed an increase in BMI is generally associated with a significant increase in the prevalence of diabetes mellitus, ($p < 0.001$). However, this metabolic disease (T2DM) was present at all levels of BMI (Figures 2). The prevalence of T2DM increased in an observable, linear fashion as BMI levels increased. The prevalence of T2DM was highest among obese individuals (BMI ≥ 30 kg/ m^2). These data reflect a dramatic relationship between the prevalence of the metabolic disease with increasing BMI. In general, the BMI distributions among adults showed most adults with T2DM were obese (BMI ≥ 30 kg/m^2 (43.3%), when BMI ≥ 25 kg/m^2 (the cut-off point for 'overweight') was applied, this percentage increased to 81.6%, meaning that 18.4% of T2DM patients were (normal) not overweight or obese.

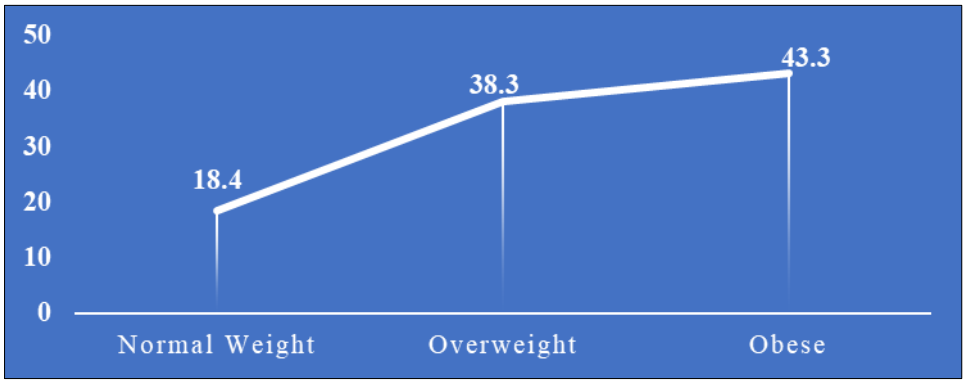

Figure 2 Prevalence of T2DM by Body Mass Index (BMI) level* *p < 0.001

4. Discussion

Obesity is probably the most important modifiable acquired risk factor in the etiology of T2DM found in many cross-sectional and longitudinal studies [40-42]. Our study found that most of our participants were classified as overweight and/or obese (BMI ≥ 25 kg/m^2), which means the probability of elevated blood sugar is expected to be common. Based on this, a steady relationship between BMI and blood glucose level founded by our study. The difference between BMI groups (normal, overweight, obese) and RBS was highly significant ($p=0.0001$). This finding is inconsistent with other findings, Skarfors ET. et al., 1991 [43], found the incidence of diabetes mellitus rose by 24 times in high body mass index (BMI) individuals compared with those who had the lowest BMI in a prospective study involving a cohort of normoglycemic Swedish men, followed up for the development of type 2 diabetes mellitus. Similarly, Kahn CR,1994 [44], found a strong positive correlation between a high BMI and the development of T2DM in a prospective study involving more than 7000 British men (mean follow-up of 12.8 years). This observation expects obesity is known to induce insulin resistance. These differences in lifestyle may account for the differences observed as exercise is known to improve insulin sensitivity [45], which is a significant determinant of random blood glucose levels (BGL) [46]. Glucose intolerance may be common among females than males in our community, these findings are consistent with other observations [47]. In this present study, BMI, and blood glucose level (BGL) were positively correlated among the 219 subjects who participated in our study, some findings were reported by (Bakari AG. et al., 2006) who investigate the

"relationship between the random blood sugar and body mass index in an African population" in a study involving 317 subjects [48], his finding therefore consistent with the increased BMI in females subjects than in males. So, a considerable risk of increased BMI in females, the tendency to be glucose intolerant.

Our results suggest that weight loss is an important preventive strategy for overweight persons with pre-diabetes, as it may delay the progression to T2DM. Besides, weight management is important for the prevention of diabetic-related complications since BMI even slightly above 25kg/m^2 puts one at a greater relative risk of a complication. The long-term weight reduction that leads to a significant decrease in diabetes incidence may be achieved by several weight loss programs, including dietary, physical activity, and behavioral interventions. To reduce the risk of developing diabetes complications for the elderly Medical Nutrition Therapy (MNT) provides education, diet and physical activity counseling, and weight-loss prescriptions (in some cases) to reduce the risk of developing diabetes complications [49]. This finding is inconsistent with others [50-54], reported that excess weight and obesity to be a major contributing factor to T2DM and its complications for both men and women. Both men and women in the overweight category (25 ≤ BMI ≤ 29.99 kg/m^2) were at an increased risk of developing T2DM, with 30% and 10% greater risks respectively. As well our results are consistent with other studies that have examined the association between BMI and risk of T2DM using nationally representative samples. Statistically significant and increasingly larger ORs for T2DM among overweight adults (1.59, 95% CI: 1.46–1.73), adults with BMI between 30 and 39.9 kg/m^2 (3.44, 95% CI: 3.17–3.74), and adults with BMI ≥ 40 kg/m^2 (7.37, 95% CI: 6.39–8.50) relative to adults with normal BMI and the risk of a T2DM diagnosis was increasingly larger for individuals in higher BMI categories than for individuals in lower BMI categories [55]. Obesity is probably the most important modifiable acquired risk factor in the pathogenesis of T2DM reported in most biochemical researches and cross-sectional studies [56]. Skarfors ET, et al., 1991 reported that a positive relationship between BMI and the incidence of diabetes mellitus by 22 times among Sweden men compared with normal BMI [57].

5. Conclusion

In the present study, we have found a positive correlation between fasting blood glucose level and BMI. The risk of developing T2DM for individuals who were overweight or obese was about triple times higher than for individuals with normal BMI, as estimated in our study. This demonstrates the importance of continuous weight management, which not only can reduce the disease burden of obesity but also may prevent further progression to T2DM. Weight management is particularly important for people with severe obesity, who were disproportionally at higher risk of developing T2DM than individuals with less severe obesity. Food habits, intensive lifestyle modifications, and regular exercise may prevent the new onset of diabetes, especially in patients with high BMI and high glucose levels. This may help in prompt treatment or preventive measures to avoid future complications.

Compliance with ethical standards

Acknowledgments

This work was generously supported and funded by the diabetes day committee at Hamad Medical Corporation – AL-Khor Hospital – state of Qatar. The authors grateful to each participant who volunteered for this study and Hamad Medical Corporation for their support.

Disclosure of conflict of interest

None declared.

Statement of informed consent

Informed consent as "Informed consent was obtained from all individual participants included in the study."

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