ORIGINAL ARTICLE

Control of Type II Diabetes, Its Relationship with Obesity and Basal Metabolic Rate

Faiza Kamal, Rozina Arshad, Bilal Bin Younis, Rashid Ahmed, Zakia Noureen, Muhammad Ahmad
Department of Medicine, Shalamar Medical and Dental College, Lahore, Pakistan

Doi: doi.org/10.53685/jshmdc.v1i1.32

ABSTRACT

Background: The prevalence of T2DM is around 7-10%. Control of diabetes and factors influencing it in third world countries need to be clearly defined as most of the people have poor glycemic control.

Methods: A cross sectional study was conducted and purposive sampling was done to collect data for 5 months. A total of 766 type 2 diabetic patients were enrolled who visited SiDER (Sakina Institute of Diabetes and Endocrine Research Center) at Shalamar Hospital, Lahore, Pakistan. Only pre-diagnosed diabetic subjects with a random blood glucose of more than 200mg/dl at two occasions and fasting blood glucose levels more than 126mg/dl were included in the study. Variables like Body Mass Index (BMI), Glycated Hemoglobin (HbA1c) and Basal Metabolic Rate (BMR) were recorded. The data was analyzed by SPSS 22 version.

Results: A total of 766 diabetics were recruited in the study out of which 40.3% were male and 59.7% were females. The mean age was 48.72±10.43 years. Out of these 53.39% were obese, 32.64% were overweight and only 13.97% had a normal body mass index BMI). HbA1c levels in the sample population showed that only 13.05% had very healthy control i.e. 7% or less. There was a positive co-relation between Body Mass Indexand glycemic control. However there was no statistically significant relation between Basal Metabolic Rateand glycemic control.

Conclusion: People with high Body Mass Index were found to have suboptimal glycemic control. It was also observed that higher percentage of diabetic patients fall in age group of 41-55 years. More powerful studies are needed to establish a relation between glycated hemoglobin and Basal Metabolic Rate.

Key Words: Diabetes Mellitus, Glycemic Control, Obesity and Basal Metabolic Rate

INTRODUCTION

Diabetes is a very common health problem with a prevalence of around 7-10% worldwide[1]. There is an equal percentage of pre-diabetics and almost 50% remain undiagnosed[2]. The most common and prevalent form of diabetes is T2DM[3]. The association of T2DM is with obesity which is an established constituent of metabolic syndrome as well. The relationship of obesity, T2DM and metabolic syndrome has been well established in literature[4]. It is a known fact that 3 major underlying mechanisms can lead to T2DM namely insulin resistance, incretin and insulin deficiencies[5]. Android obesity is common in this part of the world which leads to insulin resistance[6]. As visceral fat is the most active adipose tissue of the body, these adipose tissues are active in releasing free fatty acids in the circulation which in turn leads to insulin resistance[7,8]. One of the factors which seem to be important in determining higher Body Mass Index is Basal Metabolic Rate[9]. Low resting energy expenditure (REE) is a risk factor for weight gain [10]. Race is considered as an important variable and may have impact on Resting Energy Expenditure (REE) of the individual. There is a documented difference in Resting Energy Expenditure when compared among different races[11]. It is also observed that majority of the diabetics do not achieve target HbA1c (7%) goals, especially in developing countries[12]. It has been shown in Diabetes control and complications trial (DCCT), United Kingdom Prospective Diabetes Study (UKPDS) that long term complications can be modified by reducing the risk with tight glycemic control reflective by HbA1c and self-monitored blood glucose[13].

MATERIALS AND METHODS

A total of 766 patients were enrolled in a cross sectional study from May 2016 to October 2017, who visited SiDER (Sakina Institute of Diabetes and Endocrine Research Center) at Shalamar Hospital, Lahore, which is a tertiary care teaching hospital. The study was approved by the Institutional Review Board (IRB) of Shalamar Medical and Dental College Lahore. Purposive sampling was done and written informed consent was taken from every subject before collecting data. Only pre-diagnosed diabetic subjects with a random blood glucose of more than 200mg/dl at two occasions and fasting blood glucose of more than 126 mg/dl were included in the study. People with Gestational Diabetes, type 1 diabetes, hyperthyroid and hypothyroid were excluded. Blood was taken for Hemoglobin A1c measurement using the "High Performance Liquid Chromatography method"; with a measuring range of 4-15% HbA1c. The cut point value for HbA1c was assigned as, very healthy levels: 7% or less than 7 %, fairly healthy level: 7.1%- 8.0%, too high, needs therapeutic action 8.1-10.0% and much too high, needs therapeutic action >10.0%, labeled as category 1, 2, 3, & 4 respectively[14]. Body mass index (BMI) was calculated as weight (in kilograms)/height (in meters^2). BMI more than 30 kg/m^2 considered as obese, BMI of greater than 25kg/m^2 but less that 30 kg/m^2 were overweight and BMI of less than 25kg/m^2 but more than 18 kg/m^2 were labeled normal[15]. Harris Benedict equation was used to calculate the basal metabolic rate of the patients[16,17]. The data was analyzed by SPSS (Statistical Package for Social Sciences) 22 version. Qualitative variables were presented by mean ± S.D while quantitative variables presented by frequencies and percentages. Independent t-test, Chi- Square test and one way ANOVA were applied.

RESULTS

Table: 1 Descriptive Statistics of Type 2 Diabetics

Variables		Frequency n (%)
Gender	Male	309(40.3%)
	Female	457(59.7%)
Age groups (years)	≤25	5(0.7%)
	26-40	173(22.6%)
	41-55	411(53.7%)
	56-70	163(21.3%)
	≥70	14(1.8%)
BMI Kg/m^2	Normal	107(13.97%)
	Over weight	250(32.64%)
	Obese	409(53.39%)
Glycemic (HbA1C) Control Categories	Very healthy level	100(13.05%)
	Fairly healthy levels, needs improvement	74(9.66%)
	Too high, need therapeutic action	184(24.02%)
	Much too high, needs therapeutic action	408(53.26%)
BSR (mg/dl) mean ± S.D		264.12±99.368
BMR (Kcal) mean ± S.D		1487±218.284

Table 1; shows that out of 766 diabetics, 40.3% were male and 59.7% were females. The mean age was 48.72±10.43 years. BMI distribution shows, 53.39% were obese, 32.64% were overweight and only 13.97%were normal. There was no underweight patient. Glycated hemoglobin data shows that 13.05% of the patients fall in healthy category, 9.66% in category 2 had fairly healthy

levels and needs improvement, 24.02% in category 3, had too high A1c levels and 53.26% in category 4, had much too high and needs therapeutic action.

Table: 2 Mean Description of Glycemic Control and other Variables with Gender

Variables		Group		p-value
		Male	Female	
Age years (mean±S.D) 48.72±10.43		49.79±10.984	48.00±10.984	0.020*
Age (years)	≤25	1(0.3%)	4(0.9%)	0.045*
	26-40	63(20.4%)	110(24.1%)	
	41-55	158(51.1%)	253(55.4%)	
	56-70	78(25.2%)	85(18.6%)	
	≥70	9(2.9%)	5(1.1%)	
BMI Kg/m^2 (mean±S.D)		27.081±4.68	30.733±5.76	0.001*
BMI Kg/m^2	Normal	66(21.4%)	41(9.0%)	0.001*
	Over weight	135(43.7%)	115(25.2%)	
	Obese	108(35.0%)	301(65.9%)	
BMR Kcal (mean±S.D)		1609.77±235.16	1405±160.23	0.001*
BSR mg/dL(mean±S.D)		255±96.424	269.81±101.08	0.054
HbA1c % (mean±S.D)		10.53±3.359	11.028±3.519	0.054
Glycemic Control Categories	Very health levels (category 1)	43(13.9%)	57(12.5%)	0.499
	Fairly healthy levels, needs improvement (category 2)	34(11.0%)	40(8.8%)	
	Too high, need therapeutic action (category 3)	77(24.9%)	107(23.4%)	
	Much too high, needs therapeutic action (category 4)	155(50.2%)	253(55.4%)	

p* value <0.05 was considered statistically significant

Table 2; shows 65.9% females were obese as compared to 35.0% males. 21% of the males and only 9.0% of the females had normal BMI. Mean metabolic rate of males and females was 1609.77±235.16 and 1405±160.23 respectively. The average blood glucose levels of males and females were 255 ± 96.424 and 269.81±101.081 respectively. This shows that females had high body mass index, high blood sugar levels and too much high HbA1c as compared to males.

Table: 3 (a) Relation of Glycemic Control with Basal Metabolic Rate

Glycemic Control Categories (HbA1c)	BMR (mean±S.D)	p- value
Very health levels (category 1)	1481.17±197.98	0.096
Fairly healthy levels, needs improvement (category 2)	1513.49±237.68	
Too high, need therapeutic action (category 3)	1516.03±23	
Much too high, needs therapeutic action (category 4)	1471.9480±212.44	

p* value <0.05 was considered statistically significant

Table: 3 (b) Distribution of HbA1c with Body Mass Index (BMI)

		Body Mass Index			Total
		Normal	Over weight	Obese	
Glycemic Control Categories	Very health levels (category 1)	13(12.1%)	35(14.0%)	52(12.7%)	100(13.1%)
	Fairly healthy levels, needs improvement (category 2)	9(8.4%)	23(9.2%)	42(10.3%)	74(9.7%)
	Too high, need therapeutic action (category 3)	22(20.6%)	60(24.0%)	102(24.9%)	184(24.0%)
	Much too high, needs therapeutic action (category 4)	63(58.9%)	132(52.8%)	213(52.1%)	408(53.3%)
	Total	107(100.0%)	250(100.0%)	409(100.0%)	766(100.0%)

Table 3 (a, b) shows that as the glycemic control of the patient worsen from category 1 to category 3, their metabolic rate increases from 1481.17±197.98 to 1516.03±23 but as the glycemic control falls in category 4, the basal metabolic rate drops to 1471.9480± 212.44. This difference might be due to the fact that other factors like body mass index is also lower in this category of glycemic control, as 58.9% were normal body mass index, 52.8% were overweight and 52.1% were obese in category 4.

DISCUSSION

For the management of diabetic patients dietary advice is one of the main pillars along with education, investigations and medications. The energy expenditure is essential to assess the nutritional status of the patients. As shown in table 1, almost 86 % were above the normal weight and 53% were obese which is quite reflective of relationship between weight and diabetes[18]. The maximum number of diabetics which was 53.7% belonged to the age group (41-55 years). A significant number of diabetics belonged to a younger age group (26-40 years); which was 22.3% of all the sample diabetic population. This holds true for the other Asian population and is in contrast with Caucasian[19]. It is observed that almost 76.3% of this diabetic population belonged to age group of 26-55years, which is the prime working age for any country and forms the backbone for development. It is much needed that this particular age group with a maximum number i.e. 76.3% should be very well controlled and should be able to perform at their maximum ability level. Paradoxically when we look at the glycemic control categories in the sample population it was seen that 50.2% males and 55.4% females were in category 4. Only 13.9% in male and 12.5% in female were in category 1 of glycemic control. In this study we also compared the relationship of glycated hemoglobin levels, in obese diabetics and non-obese diabetics and subsequently the basal metabolic rate of obese diabetics and non-obese diabetics. The basal metabolic rate increases as the glycemic control worsens from category one to category three of glycemic control, however there is a decrease in basal metabolic rate in category 4. This could be due to more percentages of less body mass indices in this category. Theoretically this reduction in body mass index in this particular category could be due to increased catabolism which is not healthy[20]. The female diabetics are more than 1.5 years younger and had high body mass index as compared to their male counterparts, which is statistically significant[18]. This holds true in all age groups which were studied. Only 9% of the females can be regarded as having normal body mass index and a very significant percentage which is 65.9% was obese as compared to 35% male obese. Quite a few reasons can be debated about this very crucial finding of significantly high percentage of female obese as compared to male obese. A few causes of this obesity could be multiparty and high intake of calories during pregnancy, as a part of Asian culture. Lack of awareness about general health fitness, lack of self-

care, as it is a cultural norm that the role of female in the society is subservient and only to look after their husbands, children, husband's families specially husband's parents[20]. All these factors may lead to difficulty in finding time for their own social life and hence is translated into poor health outcome which in this case is obesity. It is also worth mentioning that this gender is also deprived of outdoor, leisure exercise facilities especially in our culture [22]. Studies in the past have shown that basal metabolic rate is higher in diabetics as compared with non-diabetics. It is also shown that this holds true when the people are converted from pre diabetics to diabetics[23]. It is also suggested that high basal metabolic rate in diabetic patients may be a cause of weight loss in uncontrolled early stages of diabetes[9]. It is interesting to look at the basal metabolic rate and comparing both the genders. In spite of the fact that there is significantly gender group as compared to the males; however their actual basal metabolic rate is low which is statistically significant. In spite of a higher body mass index in the higher socioeconomic group, the overall glycemic control is better in the high socioeconomic group i.e.17.4% had very healthy levels of A1c as compared to 11.6% in the low/ middle socioeconomic group which is statistically significant. There could be number of reasons to explain this difference, the few of them might be the better awareness, affordability and tendency to come out of unacceptable cultural norms[24]. Most of the patients in the study have high body mass index and poorly controlled diabetes. The younger age group is more vulnerable to develop diabetes and the overall glycemic control is quite poor in the studied population. Further to this, it is a relatively smaller sample size for an epidemiological cross sectional study. More powerful studies are needed in this regard, especially to establish a relation between glycated hemoglobin and basal metabolic rate. It is also recommended that a customized local guide lines should be formed for the better control. The other limitation in this study is that most of the people visiting the facility were from urban areas and it does not depict the cultural preferences of other part of the population.

REFERENCES

1. Whiting D, Guariguata L, Weil C, Shaw J. IDF Diabetes Atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Research and Clinical Practice. 2011;94(3):311-321.
2. Tuomilehto J, Lindström J, Eriksson J, Valle T, Hämäläinen H, Ilanne-Parikka P et al. Prevention of Type 2 Diabetes Mellitus by Changes in Lifestyle among Subjects with Impaired Glucose Tolerance. New England Journal of Medicine. 2001;344(18):1343-1350.
3. Wild S, Roglic G, Green A, Sicree R, King H. Global Prevalence of Diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27(5):1047-1053.
4. Leahy J. The Effect of Metformin and Intensive Lifestyle Intervention on the Metabolic Syndrome: The Diabetes Prevention Program Randomized Trial. Yearbook of Endocrinology. 2006;2006:69-72.
5. Porte D, Kahn S. Beta-cell dysfunction and failure in type 2 diabetes: potential mechanisms. Diabetes. 2001;50(Supplement 1):S160-S163.
6. Bloomgarden, MD ZT. New therapeutic approaches to non-insulin-dependent diabetes mellitus. Endocrine Practice. 1997 Sep 1;3(5):307-12.
7. Leong K, Wilding J. Obesity and diabetes. Best Practice & Research Clinical Endocrinology & Metabolism. 1999;13(2):221-237.
8. Groop L, Bonadonna R, DelPrato S, Ratheiser K, Zyck K, Ferrannini E et al. Glucose and free fatty acid metabolism in non-insulin-dependent diabetes mellitus. Evidence for multiple sites of insulin resistance. Journal of Clinical Investigation. 1989;84(1):205-213.
9. Alawad A, Merghani T, Ballal M. Resting metabolic rate in obese diabetic and obese non-diabetic subjects and its relation to glycaemic control. BMC Research Notes. 2013;6(1):382.
10. BBC NEWS. US obesity rates 'rising for first time since 2004' [Internet]. 2015. Available from: http://www.bbc.com/news/world-us-canada-34802263
11. Martin K, Wallace P, Rust P, Garvey W. Estimation of Resting Energy Expenditure Considering Effects of Race and Diabetes Status. Diabetes Care. 2004;27(6):1405-1411.
12. Mahmood K, Aamir AH. Glycemic control status in patients with type-2 diabetes. Journal of the College of Physicians and Surgeons--Pakistan: JCPSP. 2005 Jun;15(6):323-5.

13. Effect of intensive diabetes treatment on albuminuria in type 1 diabetes: long-term follow-up of the Diabetes Control and Complications Trial and Epidemiology of Diabetes Interventions and Complications study. The Lancet Diabetes & Endocrinology. 2014;2(10):793-800.
14. Weykamp C. HbA1c: A Review of Analytical and Clinical Aspects. Ann Lab Med. 2013;33(6):393
15. WHO EC. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004 Jan 10;363(9403):157.
16. Henry CJ, Rees DG. New predictive equations for the estimation of basal metabolic rate in tropical peoples. European journal of clinical nutrition. 1991 Apr;45(4):177-85.
17. Gropper S, Smith J, Groff J. Advanced nutrition and human metabolism. Australia: Wadsworth/Cengage Learning; 2009.
18. Vázquez LA, Rodríguez Á, Salvador J, Ascaso JF, Petto H, Reviriego J. Relationships between obesity, glycemic control, and cardiovascular risk factors: a pooled analysis of cross-sectional data from Spanish patients with type 2 diabetes in the preinsulin stage. BMC cardiovascular disorders. 2014 Nov 1;14(1):153.
19. Chan JC, Malik V, Jia W, Kadowaki T, Yajnik CS, Yoon KH, Hu FB. Diabetes in Asia: epidemiology, risk factors, and pathophysiology. Jama. 2009 May 27;301(20):2129-40.
20. Mäkimattila S, Nikkilä K, Yki-Järvinen H. Causes of weight gain during insulin therapy with and without metformin in patients with type II diabetes mellitus. Diabetologia. 1999 Mar 1;42(4):406-12.
21. Hayes L, White M, Unwin N, Bhopal R, Fischbacher C, Harland J, et al. Patterns of physical activity and relationship with risk markers for cardiovascular disease and diabetes in Indian, Pakistani, Bangladeshi and European adults in a UK population. J Public Health Med. 2002;24(3):170-178.
22. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. Jama. 2003 Apr 9;289(14):1785-91.
23. Bitz C, Toubro S, Larsen T, Harder H, Rennie K, Jebb S et al. Increased 24-h Energy Expenditure in Type 2 Diabetes. Diabetes Care. 2004;27(10):2416-2421.
24. Lee TC, Glynn RJ, Peña JM, Paynter NP, Conen D, Ridker PM, Pradhan AD, Buring JE, Albert MA. Socioeconomic status and incident type 2 diabetes mellitus: data from the Women's Health Study. PLoS One. 2011 Dec 14;6(12):e27670.

Corresponding Author:
Faiza Kamal
Clinical Dietitian
Shalamar Hospital
Email address: faizakamal4@gmail.com