Mediterranean Journal of Nutrition and Metabolism 9 (2016) 1–6
DOI:10.3233/MNM-160053
IOS Press

Glycemic control and its predictors among Iranian diabetic patients

Mohsen Maddah* and Leila Attarpour
Department of Human Nutrition, School of Public Health, Guilan University of Medical Sciences, Rahst, Iran

Abstract. This study evaluated the prevalence of poor glycemic control and factors associated with it among patients with type 2 diabetes in northern Iran. Totally, 367 patients (132 men and 235 women) were studied and data on their age, sex, body weight, height, weight gain in adulthood, blood pressure, lipid profile, hemoglobin A1C values, educational levels, living area, doing exercise, between meal snack and pharmacologic treatment were collected. Glycemic control was categorized as good control if A1C<7% and poor glycemic control if A1C≥7%. These data showed that 73.3% of the study patient had A1C≥7%(women 71.9% and men 75.8%, $p < 0.68$) and they had poorer metabolic control in most of laboratory parameters including blood lipid levels than good control group. In univariate analysis patients with good glycemic control were more educated, younger and were less likely to be treated with insulin than poor control patients. Poor and good glycemic patients were not different in frequency of doing regular exercise, weight gain, income levels and between meal eating behaviors. In multivariate analysis having a positive genetic background OR = 11.6 (1.4–23.9 $p > 0.02$) was positively and age >60 y OR = 6.8 (1.108–22.8 $p < 0.03$) was negatively related to glycemic control in these patients. In conclusion, a considerable proportion of these Iranian patients had poor glycemic control. These data showed that glycemic control is more difficult to obtain with increasing age indicating that duration of diabetes and delaying appropriate treatment play role in poor glycemic control.

Keywords: Diabetes, glycemic control, hemoglobin A1C, Iran

1. Introduction

Inadequate glycemic control constitutes a major health problem and important risk factor for development of diabetic complications [1–3]. Despite the evidence established the benefit of intensive glycemic control, high proportion of patients with diabetes remain poorly controlled in both developed and developing countries [4–8].

Based on a recent national data the estimated prevalence of diabetes in Iran is 8.4% and 9.4% in men and women, respectively [9]. Prevalence of poor glycemic control has not been adequately studied in Iran. In one study performed among 103 diabetic patients in Tehran, capital of Iran, 56.3% of the study patients had HbA1c (A1C) ≥7% [10]. Poor glycemic control in diabetes represents a complex interplay of metabolic, clinical, social and psychological characteristics of patients. Understanding factors influencing glycemic control can be used by

*Corresponding author: Mohsen Maddah, Golsar Ave. St.92. no: 26., Postal code: 416575145, Rasht, Iran. Tel.: +98 0911 331 3338; Fax: +98 131 3234155; E-mail: maddahm@yahoo.com.

ISSN 1973-798X/16/$35.00

health care providers for targeted intervention to patients at greatest risk of diabetic complications. This study was to assess the prevalence of poor glycemic control and factors associated with it among patients with type 2 diabetes attended Dietetic Center for Diabetes in Rasht, northern Iran.

2. Subjects and method

This is a cross sectional study of men and women with type 2 diabetes. We recruited consecutive patients diagnosed with type 2 diabetes referred to Rasht Nutrition and Diet Therapy Clinic in northern Iran between March 2012 and March 2013. Eligible patients were clinic patients, 18 years of age or older, with a diagnosis of type 2 diabetes in the medical records. Those patients who were pregnant or were too ill or cognitively impaired were excluded.

Patients' medical records were reviewed to identify if complete laboratory data are available and eligible patients were provided a description of the study. Those interested and eligible gave a written consent and completed the study. Totally, 367 subjects (132 men and 235 women) completed the study.

We collected data on self- reported age, sex, original body weight if available (body weight around 20 years), educational levels, doing regular exercise, between meal snack, skipping breakfast, living area, and duration of walking per day. Body weight was measured to the nearest 0.1 kg using a balanced beam scale wearing light clothing without shoes; height was measured to the nearest 0.5 cm under the same conditions. Additional data included pharmacologic treatment namely hypoglycemic (oral hypoglycemic agents or insulin), anti-hypertensive, blood lipid lowering, and anti-psychiatric agents. Total serum cholesterol, high density lipoprotein cholesterol (HDL-C), and triglyceride (TG) were measured by commercially available enzymatic reagents (Pars Azmon, Iran) adapted to a selectra autoanalyzer. The Friedewald method was used to determine serum low density lipoprotein cholesterol (LDL-c) in samples with serum TG levels less than 400 mg, while serum LDL-c was measured by commercially available enzymatic reagents (Pars Azmon, Iran) adapted to selectra autoanalyzer when serum TG level exceed 400 mg/dl. Serum alanin aminotransferase (ALT), aspartate aminotransferase (AST), glucose concentrations and A1c levels were measured in fasting state by commercially enzymatic reagents (Pars Azmoon, Iran). Weight gain during adulthood was calculated as current body weight minus original weight.

The diagnosis of diabetes was based on the American Diabetic Association (ADA) criterion (11). Systolic and diastolic blood pressures were measured in all study men and women and hypertension was defined as either two standard readings equal or more than 130/80 or being on antihypertensive medications [11]. A primary measure of glycemic control is hemoglobin A1C (11). Glycemic control was categorized as good control if A1C<7% and poor glycemic control if A1C$\geq$7% (11). Criteria for abnormal lipid profile levels were based on the ADA definitions (11). Hypercholesterolemia refers to a total cholesterol level $\geq$200 mg/dl. HDL was considered low when the level was <40 mg/dl in both males and females. LDL was considered high when the level was $\geq$100 mg/dl. Hypertriglyceridemia refers to a level $\geq$150 mg/dl. Patient's receiving medication for any of the above conditions were classified as having the condition.

The study protocol was approved by the ethical committee of Guilan University of Medical Sciences.

2.1. Statistical analysis

Differences in demographic variables between good and poor control glycemic patients were tested using Chi square statistics. In data analysis, level of education were classified as less than 12 years of schooling, high school diploma (=12 years schooling) and college or university study (>12 years schooling). The families were categorized by their living area (home address) as living in low income areas and living in high income areas. We ran a multiple regression model to assess the independent effect of measured variable on glycemic control. *P*-values less than 0.05 were considered as the level of significance. Analyses were performed using Statistical Package for Social Science (SPSS 10.01 for windows, SPSS Inc® headquarter, Chicago, IL, USA).

Table 1
Characteristics of the study patients with poor and good glycemic control

	A1C<%7 ($n=94$)	A1C≥%7 ($n=253$)	P-value
Age (year)	52.2 ± 12.5	53.2 ± 11.3	0.45
Weight gain (kg)	21.4 ± 13.7	19.1 ± 12.7	0.30
FBS (mg/dl)	134.4 ± 36.8	183.9 ± 62.5	0.00001
BS (mg/dl)	190.9 ± 67.4	271.9 ± 96.7	0.00001
A1 C (mg/dl)	6.2 ± 0.5	9.2 ± 1.6	0.00001
ALT (mg/dl)	31.6 ± 19.4	30.3 ± 19.0	0.69
AST (mg/dl)	25.1 ± 12.0	24.8 ± 18.4	0.94
TG (mg/dl)	189.1 ± 133.9	205.5 ± 122.1	0.38
LDL (mg/dl)	95.2 ± 33.3	99.6 ± 35.0	0.39
HDL (mg/dl)	43.6 ± 10.0	43.0 ± 10.3	0.68

3. Results

Mean age, weight gain and laboratory data of the study diabetic patients by their A1C levels was presented in Table 1. Prevalence of poor glycemic control was not statistically different between men and women. While poor and good glycemic patients were not different in mean blood lipid levels the rates of achieving for LDL-cholesterol (<100 mg/dl), HDL-cholesterol (>40 mg/dl), and TG<150 mg/d were different between the two groups (Table 2). These data showed that patients with good glycemic control (A1C<7%) were more educated and younger than poor control patients. Poor and good glycemic patients were not different in frequency of doing regular exercise, weight gain, skipping breakfast and income level judged by living area. These data showed that patients with poor glycemic control were more likely to be treated with insulin. In multiple binary regression analysis having a positive genetic background was positively OR = 11.6 (1.4–23.9) $P < 0.02$ and age >60 y OR = 6.8 (1.108–22.8) $P < 0.03$ was negatively related to glycemic control. Educational levels, weight gain, gender and other measured variables were not independently related to glycemic control in this population of diabetic patients.

4. Discussion

In Iran, any patient in urban areas may decide to be visited by a general practitioner or a specialist in public or in private sectors. Despite high prevalence of type 2 diabetes in Iran [9], there is less data on glycemic control among diabetic patients. Our results showed that a high proportion (%73.3) of the study diabetic patients were poor glycemic control. Poor control is not uncommon among diabetic patient in other countries in the region. In Kuwait, 66.7% of the studied population had A1C≥8% [12]. In Pakistan, 46.7% had A1C >7% [13]. In Saudi Arabia, only 27% of the patients reached target level of glycemic control [14].

Achieving optimal glycemic control requires the diabetes patient to take part in a set of tasks including obtain and adhere to dietary advice and medications. These results are in agreement with findings from other studies that showed age and longer duration of diabetes is associated with poor control possibly because of progressive impairment of insulin secretion with time because of B cell failure which makes the response to diet alone or oral agent unlikely [15, 16].

While more educated patients had better value of A1C in univariate analysis we found that neither living areas (high/low income) nor educational levels were independently related to glycemic control in this group of diabetic patients. These findings are in agreement with most other data from western countries [5, 17]. Meanwhile there

Table 2
The proportion of measured variables (%) in good and poor glycemic control diabetic patients (132 men and 235 women)

	A1C<7%	A1C≥7%
Sex		
Male	24.2	75.8
Female	28.1	71.9
Age		
<40 years	26.5	19.3*
40–60 years	43.9	50.6
>60 years	25.5	23.8
Educational levels		
<12 years	29.5	35.5
=12 years	36.4	34.7
>12 years	34.1	29.8**
Living in low income areas	38.6	39.0
Positive diabetes genetic	83.9	77.9
Doing regular exercise	6.1	5.2
Walking (min/day)		
>15	55.2	55.5
15–30	22.4	22.6
30	22.4	21.9
Weight gain in adulthood (kg)		
<10	24.5	29.6
10–20	32.7	32.2
>20	42.9	38.3
LDL>100 mg/dl	23.5	30.1*
HDL<40 mg/dl	27.6	34.6*
TG>150 mg/dl	38.8	50.6*
Skipping breakfast	20.9	16.1
Snack between meals	29.9	20.8*
Medications		
Insulin/OHA	11.2	19.7*
OHA	70.4	85.5*
Anti-hypertensive	49.0	45.0
Anti-lipid agents	66.3	61.7
Anti-psychiatric agents	12.2	19.1*

*$P < 0.05$, **$P < 0.001$.

are some data showing that patients from lower socioeconomic levels are at greater risk for poor glycemic control [18]. Weather health literacy varies across socioeconomic levels in Iranian diabetic patients need to be clarified by further studies.

We found prevalence of poor glycemic control was not different between men and women. Gender was not associated to poor glycemic control in some studies [15, 17] while others indicated that women may more likely to have poor glycemic control than men (7, 18).

Our finding showed that patients with poor glycemic were more likely to be prescribed combination of oral anti-diabetic agents and insulin. The same finding was reported by other studies [16, 19]. Diabetes is a progressive

disease and more aggressive treatment is needed to provide glycemic control. Delaying in applying insulin in treatment of patients with poor glycemic control can also be a reason.

In this study all the patients were adherent to the anti-diabetic drugs as prescribed. However, it has been reported that poor glycemic control was more common among patients who were not adherent for medications [16]. Therefore, patients should be motivated to use the medications as prescribed.

These results showed that 77.2% of the study population had with positive family history for diabetes. Our finding that positive history of disease may protect some patients against poor glycemic control is in contrast to other reports [17]. We cannot give any evidence to explain how having a family member with diabetes may positively affect glycemic control and more detailed studies are needed to clarify this matter.

This study showed that most study patients did not engage in regular exercise. We found no significant association between doing regular exercise and glycemic control among this group of diabetic patients. Other studies also did not show performing exercise may result in better glycemic control [15, 16, 20]. However, role of physical activity in new onset diabetes and especially in overweight patients in decreasing insulin resistance is indisputable [21].

These data showed that poor glycemic control patients had poorer metabolic control in most of laboratory parameters including blood lipid levels. This finding is agreement with other studies showing that good glycemic control results in better control of other risk factors [7]. Poor control of blood lipid levels can be resulted from poor glycemic control and/or obtaining and adhering to right medications and dietary advice. Our results showed that patients who had good glycemic control tended to have between meal snacks more often than poor control patients. Having small frequent meals is recommended in controlling blood glucose levels [22]. While most study patient experienced considerable weight gain during adulthood the two groups were not different in weight gain. However modest weight loss is needed for better glycemic control [22].

There are some limitations in this study. We did not collect data on self- care management behavior including blood glucose testing. We assessed income levels indirectly by asking living area as data on income is usually underreported by Iranian families. We also did not collected data on complications of diabetes among our patients. Furthermore we could not compare the management of patients with diabetes in primary and tertiary levels.

In conclusion, the present study indicated that a large proportion of the study diabetic patients had poor glycemic control. These data showed that variables such as educational levels, obesity, living areas, sex and doing exercise were not predictors of poor glycemic control. Age was an independent determinant of glycemic control indicating that duration of diabetes and delaying appropriate treatment is an important barrier for glycemic control in these patients. This study highlights the importance of performing more research to identify barriers on glycemic control in diabetic patients in Iran.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgments

We thank our patients for their participation in this study. This work was financially supported by Guilan University of Medical Sciences.

References

[1] Stratton IM, Adler AI, Neil HAW, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS). Propective observational study. BMJ 2000;321:405-12.

[2] Schellhase KG, Koepsell TD, Weiss NS. Glycemic control and the risk of multiple microvascular diabetic complications. Fam Med 2005;37:125-30.

[3] The Diabetes Control and Complications Trial Research group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in Insulin dependent diabetes mellitus. N Engl J Med 1993;329:977-86.

[4] Saaddine JB, Cadwell B, Gregg EW, et al. Improvements in diabetes process of care and intermediate outcomes: United States, 1988-2002. Annals of Internal Medicine 2006;144:465-74.

[5] Fox KM, Gerber RA, Bolinder B, Chen J, Kumar S. Prevalence of inadequate glycemic control among patients with Type 2 diabetes in the United Kingdom general practice research data base: A series of retrospective analysis of data from 1998 through 2002 2006; Clinical Therapeutics 28;388-95.

[6] Cheong AT, Lee PY, Sazlina SG, Adam BM, Chew BH, Mastura I, Jamaiyah H, Alwi SS, Wahyu TS, Nafiza MN. Poor glycemic control in younger women attending Malaysian public primary care clinic: Finding from adult diabetes control and management registry. BMC Family Practice 2013;14:188-95.

[7] Gopinath B, Sri Sai Parasad M, Jayarama N, Prabhakara K. Study of factors associated with poor glycemic control in type -2 diabetic patients. GJMED H 2013;2:1-5.

[8] Ezenwaka CE, Offiah NV. Differences in glycemic control and cardiovascular risk in primary care patients with type 2 diabetes in west Indies. Clinical and Experimental Medicine 2001;2:91-8.

[9] Esteghamati A, Meysamie A, Khalilzadeh O, et al. Third national Surveillance of risk factors of non-communicable disease (SuRFNCD-2007) in Iran: Methods and results on prevalence of diabetes, hypertension, obesity, central obesity, and dyslipidemia. BMC Public Health 2009;29:167.

[10] Ghazanfari Z, Niknami S, Ghofranipour F, Larijani B, Agha-Alinejad H, Montazeri A. Deteminant of Glycemic control in female diabetic patients: A study from Iran. Lipids in Health and Disease 2010;9:83-7.

[11] American Diabetes Association: Standards of medical care in diabetes-2010. Diabetes Care 2010;33(Suppl 1):S11-S61.

[12] Al-sultan FA, Al-Zank N. Clinical epidemiology of type 2 diabetes in Kuwait. Kuwait Medical Journal 2005;p 37:98-104.

[13] Habib SS, Aslam M. Risk factors, knowledge and health status in diabetic patients. Saudi Medical Journal. 2003;24:1219-24.

[14] Akbar DH. Low rates of diabetic patients reaching good control targets. Eastern Mediterranean Health Journal 2001;7:671-8.

[15] Blaum CS, Velez L, Hiss RG, Halter J. Characteristics related to poor glycemic control in NIDDM patients in community. Diabetes Care 1997;20:7-11.

[16] Khattab M, Khader YS, Al-Khawaldeh A, Ajlouni K. Factors associated with poor glycemic control among patients with Type 2 diabetes. Journal of Diabetes and its Complications 2010;24:84-9.

[17] Almutairi MA, Said MS, Zainuddin H. Predictors of poor Glycemic control among type two diabetic patients. American Journal of Medicine and Medical Sciences 2013;3:17-21.

[18] Shani M, Taylor TR, Vinker S, Lusman A, Erez R, Elbayany A, Labad A. Characteristic of Diabetic patients with poor glycemic control who achieve good control. JABFM 2008;21:490-6.

[19] Koro CE, Bowlin SJ, Bourgeois N, Fedder DO. Glycemic control from 1988-2000 among U.S adult diagnosed with type 2 DM. Diabetes Care 2004;27:17-20.

[20] Juarez DT, Sentell T, Tokumaru S, Goo R, Davis JW, Mau MM. Factors associated with poor glycemic control or wide glycemic variability among diabetic patients in Hawaii 2006-2009. Pre Chronic Dis 2012;9:12.

[21] Canadian Diabetes Association: Physical activity and diabetes. Can J Diabetes 2013;37:S40-4.

[22] American Diabetes Association guide to nutrition therapy for diabetes, 2th ed. USA: 2012.