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Knowledge of blood sugar control standard brings the higher attainment rate of HbA1c

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ABSTRACT

Objective: To analyze the important controllable factors which affect the glycemic control of diabetes.

Methods: A cross-sectional study was carried out to examine the role of relevant characteristics in glycemic control by a sampling investigation of 430 diabetic patients in Hunan, China. A questionnaire was designed for personal interviews to collect data. Univariate regression analysis and multiple linear regression analysis were used to evaluate the effects of various factors on glycated hemoglobin A1c (HbA1c) control.

Results: The level of HbA1c in 430 patients was (8.7±2.6)%, and the value in 34% patients among them was ≤7.0%. Base on univariate regression analysis some factors were associated with good HbA1c control, including age, diabetic education, self monitoring of blood glucose, knowledge of blood sugar control standard, living environment, and self-owned glucometer. However, the upgraded treatment was associated with poor control. Based on multiple linear regression analysis, the first four factors mentioned above were protective factors for HbA1c while upgraded treatment was risk factor for HbA1c.

Conclusion: Knowledge of blood sugar control standard, diabetic education and self monitoring of blood glucose are important controllable factors for better glycemic control of diabetes.

KEY WORDS diabetes education; self monitoring of blood glucose; knowledge of blood sugar control standard; glycated hemoglobin A1c

高的血糖达标值知晓率可以提高糖化血红蛋白达标率

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[摘要]**目的：**探讨和分析影响血糖的可控因素。**方法：**采用横断面研究方式，选择已确诊3个月以上的糖尿病患者430人，通过调查问卷的形式收集其人口统计学资料、临床及其他可能与血糖控制相关的资料，同时收集其血液标本测定糖化血红蛋白值(HbA1c)。采用多元线性回归分析与单因素回归分析方法进行统计分析，分析各因素对HbA1c控制达标的影响。**结果：**430例糖尿病患者HbA1c为(8.7±2.6)%，34%的糖尿病患者HbA1c≤7.0%。单因素回归分析发现年龄越大、参加糖尿病教育、更高频率的血糖监测、对血糖控制目标的知晓、更好的公共卫生环境、拥有血糖仪的患者HbA1c控制较好，但是升级的治疗方法，如胰岛素治疗的患者HbA1c控制较差。多元线性回归分析发现年龄越大、参加糖尿病教育、更高频率的血糖监测、对血糖控制目标的知晓是HbA1c的保护因素，升级的治疗方法是HbA1c的危险因素。**结论：**对血糖控制目标的知晓、参加糖尿病教育、更高频率的血糖监测是有利于HbA1c达标的可控因素，且提高血糖控制目标的知晓率可能是降低患者HbA1c最简单有效的方法。

[**关键词**] 糖尿病教育；自我血糖监测；对血糖控制目标的知晓；糖化血红蛋白

Because of the rapid change in lifestyle in China, the prevalence of diabetes in China is increasing epidemically. From the research of Yang et al[1] during June 2007 to May 2008, we knew the prevalence of total diabetes and prediabetes were 9.7% and 15.5%, accounting for 92.4 million adults with diabetes and 148.2 million adults with prediabetes in China. So looking for effective diabetes prevention and treatment measures is particularly important at present. As we all know diabetes care and diabetes education are very important for improving glycemic control, reducing diabetes complications, and improving living quality. The execution of diabetes education in China mainly depends on the doctors and the nurses. Individual education for outpatients and collective education in hospitals or communities in cities are the main forms to carry out diabetes education in China.

The purpose of diabetes education is for better control of blood sugar. Glycemic control is very essential in diabetes management, and a good control leads to reduced rates[2-4] of nephropathy, neuropathy, retinopathy, cardiovascular disease, and decreased morbidity and mortality[2]. Because glycated hemoglobin A1c (HbA1c) indicates the average blood glucose during the past 3 months, it is always used as a gold standard in analysis of patients' status of blood sugar control.

Though a strict glycemic control could reduce macrovascular and microvascular complications[5-7], a high proportion of patients are still remained poorly controlled[8]. The reasons are complex, and some researchers have identified a variety of factors in influencing glycemic control, such as sex, age, education, diabetes duration, body mass index (BMI), smoking, and type of medications[9-12]. Because the results are not consistent and there still more than half of the variances in HbA1c changes can not be explained[11], our study tries to find some other important controllable factors which influence glycemic control.

How to do a better education and let it benefit more patients with diabetes is worth considering. In our daily clinical work, we have noticed that patients who have no idea of the blood sugar control target always get a poor blood glucose control compared with the patients who know well. The blood sugar control standard is a very important diabetes education knowledge point, but no one has studied it as a separated factor which may affect the blood glucose control, so our study aims to regard it as a separated factor besides age, sex, education, diabetes education and others.

1 Subjects and methods

1.1 Subjects

A cross-sectional study was carried out to examine the role of demographic, anthropometric, clinical and other relevant characteristics in glycemia control among diabetic patients who attended the Department of Endocrinology, Xiangya Hospital, Central South University between March 2009 and December 2009. The inclusion criteria were: aged more than 18 years, diagnosed diabetes for more than 3 months, no history of mental and disabling disorders. Internists were trained for carrying out face-to-face interviews.

The study was approved by the Ethics Committee of Central South University. Written informed consent was obtained from all the participants after comprehensive and detailed explanation of the procedure involved.

1.2 Methods

Demographic information included data on age, sex, income, duration of diabetes, education, family history of diabetes mellitus, living environment, profession, diabetes education. Living environment in this study refers to the medical services in our living environment, health care resources in China are mainly concentrated

in big cities, and thus according to the patients living in rural areas, towns or capital cities to determine the medical condition of the environment. Anthropometrics information included data on waist circumference, hip circumference, and the BMI. Clinical information includes data on HbA1c and treatment. The data of the patients who had their HbA1c measured within 3 months were straightly collected, and the HbA1c of the ones who hadn't was sent to the clinical laboratory and measured by a BIO-RAB-D10 type HbA1c radiometer. Other information included the knowledge of blood sugar control standard, glucometer, self-monitoring blood glucose. Blood sugar control standard: fasting blood glucose (FBS)=4.4–6.1 mmol/L (79.2–109.8 mg/dL); postprandial blood sugar (PBS)=4.4–8 mmol/L or (79.2–144 mg/dL). If the answer of the patient for the blood sugar control standard was in the range, we defined it a correct answer.

1.3 Statistical analysis

Statistical analysis were performed by using SPSS16.0. Measured data were expressed as means±standard deviation (SD). Both univariate regression and multivariate regression analysis were used to indicate the association between the dependent and independent variables. Independent variables included age, sex, income, duration of diabetes, education, family history of diabetes mellitus, living environment, profession, diabetic education, waist circumference, hip circumference, BMI, knowledge of blood sugar control standard, glucometer, self-monitoring blood glucose, and treatment.

The variables which were proved have a significant association in univariate regression analysis ($P<0.05$) were included in backward stepwise multiple regression analysis.

2 Results

We recruited 430 diabetes patients. All the participants completed the survey. The average age was 56.9 years, ranging from 19 to 84 years. The man ratio was 51%. Two hundred and eighty (65%) patients accepted no education or only accepted primary education. The mean value of HbA1c for the whole sample group was 8.7% (SD=2.6%) and 67.4% HbA1c value was ⩾7%. Among 125 people who knew the FBS or PBS control target, only 2 people knew the PBS control target. The clinical characteristics of the participants were shown in Table 1.

Table 1 Characteristics of diabetes patients (n=430)

Indices	Data
Age/years	56.9±12.3
Male /%	51
Family history of diabetes/%	
Yes	23
No	77
Educational level/%	
Illiteracy	5
Low	60
Middle	20
High	15
Duration of diabetes /years	5.2±5.3
Waist circumference	87.5±9.4
Hip circumference	95.1±7.2
BMI/(kg/m^2)	23.6±3.3
Income	
<10000 RMB per year	48
⩾10000 RMB per year	52
Diabetes education/%	
Yes	44
No	56
Self-monitoring blood glucose/%	
<1 times per quarter	28
⩾1 times but <3 times per quarter	10
⩾1 times but <3 times per month	31
⩾1 times per week	30
Blood glucose meter/%	
Yes	32
No	68
KBSCS/%	
Did not know FBS or PBS control standands	47
Know FBS or PBS control standands	29
Know FBS and PBS control standands	24
Treatment/%	
Diet only	4
OHA	49
Insulin	36
Insulin + OHA	11
Living environment/%	
Country	22
City	55
Capital city	23
HbA1c /%	8.7±2.6

KBSCS: Knowledge of blood sugar control standard; FBG: Fasting blood glucose; PBS: Postprandial blood sugar; OHA: Oral hypoglycaemic agent.

In univariate regression (Table 2), variables including age (b=–0.162, P=0.001); diabetes education (b=–0.392, P<0.001); self monitoring of blood glucose (b=–0.211, P<0.001); knowledge of blood sugar control standard (b=–0.406, P<0.001); better living environment (b=–0.219, P<0.001); owning glucometer (b=–0.152, P=0.002); treatment (b=0.155, P=0.001) were associated with HbA1c levels. The former six factors were negatively correlated with HbA1c level, while treatment was positively correlated with HbA1c level. The above variables were entered in backward stepwise multiple regression analysis. Table 3 showed the variables in the model. These variables accounted for 26.4% of the variance in HbA1c (total R^2=0.264) and knowledge of blood sugar control standard was the most important impact factor (b= –0.243).

Table 2 Associations between patient characteristics and HbA1c level of diabetes patients

Independent variables	b^*	95% CI for b	P
Age	–0.162	–0.0005; –0.0001	0.001
Sex	–0.048	–0.007; 0.002	0.325
Family history of diabetes	–0.052	–0.009; 0.003	0.285
Educational level	–0.038	–0.004; –0.002	0.429
Duration of diabetes	–0.054	$-7.35E^{-4}$; $2.03E^{-4}$	0.265
Waist circumference	0.020	$-2.07E^{-4}$; $3.19E^{-4}$	0.675
Hip circumference	–0.005	$-3.66E^{-4}$; $3.27E^{-4}$	0.912
BMI	–0.072	–0.001; –0.0002	0.139
Income	–0.065	–0.008; 0.002	0.179
Diabetes education	–0.392	–0.025; –0.016	<0.001
Self-monitoring blood glucose	–0.211	–0.007; –0.003	<0.001
Blood glucose meter	–0.152	–0.014;–0.003	0.002
KBSCS	–0.406	–0.016; –0.010	<0.001
Treatment	0.155	0.002; 0.009	0.001
Living enviroment	–0.219	–0.012; –0.005	<0.001
Profession	0.069	$-2.22E^{-4}$; 0.001	0.154

*The regression coefficient b reflects the estimated difference in HbA1c level as a result of one unit increase in the independent variable.

Table 3 Multiple linear regression analyses between HbA1c and patient characteristics of diabetes patients

Independent variables	b^*	95% CI for b	P
Diabetes education	–0.187	–0.015; –0.004	0.001
Self-monitoring blood glucose	–0.117	–0.005; $-6.6E^{-4}$	0.009
Age	–0.135	$-4.6E^{-4}$;$-1.1E^{-4}$	0.001
KBSCS	–0.243	–0.011; –0.004	<0.001
Treatment	0.194	0.004; 0.010	<0.001

Excluded variables were blood glucose meter and living environment. 26.4% of the variance of HbA1c was explained by the variables in the model (total R^2=0.264). *The regression coefficient b reflects the estimated difference in HbA1c level as a result of one unit increase in the independent variable.

3 Discussion

This study examined factors associated with the HbA1c control of diabetes patients. The factors like sex, family history of diabetes, education level, duration of diabetes, waist circumference, hip circumference, BMI, income had no significant relationship with HbA1c level.

A number of factors investigated in our study have been shown to be important in diabetes control including age, diabetes education, knowledge of blood sugar control standard, self-monitoring blood glucose and treatment. The older the age, the better the HbA1c, this findings is consistent with our clinical work and the studies of Shanghai[13], Hunan[14] and international study [15]. We

analyze that it is because older people especially the retired people always have more time to pay attention to their health problem, they visit doctors more frequently and have a better compliance. Various factors that may affect glycemic control in younger patient with diabetes and older patients remain to be compared and discussed.

Diabetes education is reported[16-17] to be very important for blood glucose control of diabetes, and our study is consistent with the researches. How to conduct diabetes education is a question which scholars around the world are thinking about[18]. In our country the diabetes education is mainly carried out in cities, individual education for outpatients and collective education in hospitals or communities are the main forms, telemedicine form is lack compared with developed countries. In China, rural population ratio is more than 50%, thus the vast majority of Chinese people could not receive diabetes education.

Glycemic control target is an important knowledge point in diabetes education, and no one has studied it as a separated factor which might affect the blood glucose control. In our study we have found the knowledge of glycemic control standard is the most important factor which affects the HbA1c level of the diabetes and the awareness rate is very low—only 24%. In addition, we found the knowledge level of postprandial blood sugar was lower than the knowledge level of fasting blood sugar control standard. Considering that the damage of blood sugar fluctuation on the target organs is more serious than the persistent high blood glucose level[19], we think the knowledge level of blood sugar control standard especially the knowledge level of postprandial blood sugar is the most fundamental and important measure. From our study, we knew the education level of the patients was still low, so it was not practical to teach them complex diabetes educational knowledge. We found that increasing KBSCS might be a most effective and practical method to control the HbA1c level.

In this study, we also found self monitoring of blood glucose was important for HbA1c control, and it is consistent with the prior studies[15,20]. We analyzed that self monitoring of blood glucose distinguished among fasting, preprandial and postprandial hyperglycemia and provided immediate feedback about the effect of food choices, activity and medication on glycemic control, so it was an important basis for patients' adjustment of food, activity, medicine or insulin. There is a need for better systems in which the patient should be layered according to education level and gave vary levels of diabetes education, and increasing KBSCS. Self-monitoring blood glucose should always be the foundation of diabetes education.

In our clinical work, we found that upgraded medical treatment was really effective for some diabetes poorly controlled. To the contrary, we found that the blood glucose of the diabetes patients who were given more intensive treatment or more medication was more poorly controlled than those who accepted based treatment in our study. We thought the difference of illness severity caused it—the condition of the diabetes patient who accepted more intensive treatment was more serious than those who accepted based treatment, and no the treatment itself caused the difference.

Blood glucose meter and living environment which included in univariate regression analysis were excluded from the multiple linear regression analysis. We analysed that the owning of blood glucose meter might play its role in glycaemic control through self monitoring of blood glucose, and living environment for example city or country might play its role though the difference in diabetes education, self monitoring of blood glucose and knowledge of blood sugar control standard.

The findings from our study might be influenced by several limitations. First, all patients were recruited from a single institute rather than being a community-based sample, so the findings could not be generalized beyond our study sample. Second, some indexes in this study were self-reported by the patient, so we should not neglect the possibility of recall bias.

Our findings confirm that older age, diabetic education, higher frequency of blood sugar determination, knowledge of blood sugar control standard are all independent determinants for good glycemic control, and the latter three are all modifiable factors.

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References

1. Yang W, Lu J, Weng J, et al. Prevalence of diabetes among men and women in China[J]. N Engl J Med, 2010, 362(12): 1090-1101.
2. Middleton J. The effect of case management on glycemic control in patients with type 2 diabetes[J]. Case Manager, 2003, 14(6): 43-47.
3. Bevan JL. Diabetes mellitus: a review of select ADA standards for 2006[J]. J Nurse Pract, 2006, 2(10): 674-679.

4. American Diabetes Association. Standards of medical care in diabetes–2009[J]. Diabetes Care, 2009, 32 (Suppl 1): S13-S61.
5. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study[J]. BMJ, 2000, 321(7258): 405-412.
6. Saaddine JB, Cadwell B, Gregg EW, et al. Improvements in diabetes processes of care and intermediate outcomes: United States, 1988-2002[J]. Ann Intern Med, 2006, 144(7): 465-474.
7. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33)[J]. Lancet, 1998, 352(9131): 837-853.
8. Karter AJ, Moffet HH, Liu J, et al. Achieving good glycemic control: initiation of new antihyperglycemic therapies in patients with type 2 diabetes from the Kaiser Permanente Northern California Diabetes Registry[J]. Am J Manag Care, 2005, 11(4): 262-270.
9. Khattab M, Khader YS, Al-Khawaldeh A, et al. Factors associated with poor glycemic control among patients with type 2 diabetes[J]. J Diabetes Complications, 2003, 24(2): 84-89.
10. Hartz A, Kent S, James P, et al. Factors that influence improvement for patients with poorly controlled type 2 diabetes[J]. Diabetes Res Clin Pract, 2006, 74(3): 227-232.
11. Goudswaard AN, Stolk RP, Zuithoff P, et al. Patient characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care[J]. Eur J Epidemiol, 2004, 19(6): 541-545.
12. Wallace TM, Matthews DR. Poor glycaemic control in type 2 diabetes: a conspiracy of disease, suboptimal therapy and attitude[J]. QJM, 2000, 93(6): 369-374.
13. Wang JQ, Tak-Ying Shiu A. Diabetes self-efficacy and self-care behaviour of Chinese patients living in Shanghai[J]. J Clin Nurs, 2004, 13(6): 771–772.
14. He CY, Shiu AT. Sense of coherence and diabetes-specific stress perceptions of diabetic patients in central Mainland China[J]. J Clin Nurs, 2006, 15(11): 1460–1462.
15. Hartz A, Kent S, James P, et al. Factors that influence improvement for patients with poorly controlled type 2 diabetes[J]. Diabetes Res Clin Pract, 2006, 74(3): 227-232.
16. Selea A, Sumarac-Dumanović M, Pesić M, et al. The effects of education with printed material on glycemic control in patients with diabetes type 2 treated with different therapeutic regimens[J]. Vojnosanit Pregl, 2011, 68(8): 676-683.
17. Salinero-Fort MA, Carrillo-de Santa Pau E, Arrieta-Blanco FJ, et al. Effectiveness of PRECEDE model for health education on changes and level of control of HbA1c, blood pressure, lipids, and body mass index in patients with type 2 diabetes mellitus[J]. BMC Public Health, 2011, 11: 267.
18. Klein HA, Jackson SM, Street K, et al. Diabetes self-management education: miles to go[J]. Nurs Res Pract, 2013, 2013: 581012.
19. Marcovecchio ML, Lucantoni M, Chiarelli F. Role of chronic and acute hyperglycemia in the development of diabetes complications[J]. Diabetes Technol Ther, 2011, 13(3): 389-394.
20. Blevins T. Value and utility of self-monitoring of blood glucose in non-insulin-treated patients with type 2 diabetes mellitus[J]. Postgrad Med, 2013, 125(3): 191-204.

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