

Current status of comprehensive metabolic control and predictive model of blood glucose control in low-income patients with type 2 diabetes

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Research Article

Keywords: Comprehensive metabolic, Blood glucose control, Type 2 diabetes, Low-income group

Posted Date: April 30th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-447790/v1>

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Abstract

Objective: The purpose of this study was to comprehensively evaluate and explore the current situation of comprehensive metabolic control, the factors that influence glycemic control and the relationships among these factors in patients with type 2 diabetes in a low-income population.

Method: A total of 462 outpatients and inpatients with type 2 diabetes who met the national standard of low income were selected by random sampling. The Diabetes General data questionnaire, the Chinese version of Diabetes Distress Scale (DDS) and the Diabetes Knowledge and Self-Management Behavior Scale were administered, and HbA1c, blood pressure, blood lipid and BMI were examined to comprehensively evaluate the psychology, management knowledge, behavior and control status of diabetes mellitus. Then, multiple linear regression analysis was carried out.

Results: The total score of the knowledge behavior was 89.57 ± 19.00 , and 104 patients (22.5%) met the threshold for the Diabetes Knowledge and Self-Management Behavior Scale. Diabetes-related health knowledge and ability were negatively related to HbA1c. A total of 73.81% of patients reported diabetes-related psychological pain, and the most common dimension of which was psychological pain was the emotional burden. The total score of the DDS and scores on each dimension were positively related to HbA1c levels. Multiple linear regression showed that the main factors affecting blood glucose control were the total score of the knowledge and behavior scale, interpersonal-related pain, time of diabetes diagnosis, age, diabetic nephropathy, emotion-related pain, gender, and smoking status.

Conclusion: The comprehensive metabolic control status of low-income type 2 diabetes patients is much lower than indicated by the results of 3B research. Because self-management behavior in the knowledge of diabetes is the most important factor affecting blood glucose control and there is a correlation between self-management behavior and diabetes psychology, according to the heterogeneity of diabetes, it is important to consider how to make full use of the Internet and other methods to carry out individual, accurate and effective care to promote comprehensive metabolic control among low-income patients with type 2 diabetes.

Introduction

The rising prevalence of diabetes and its multiple complications seriously affect people's quality of life, resulting in a heavy economic burden [1]. It has become important to actively carry out scientific research, seek effective three-level prevention strategies and prevent the impact of national economic development. The comprehensive metabolic control of diabetes is the key to the prevention of complications [2, 3]. In recent years, a series of new drugs have been developed in the field of diabetes treatment. High-tech equipment has been used, such as instantaneous dynamic blood glucose meters. A large number of scholars have developed management models such as "authorization, peers" [3, 4]. Although the model has yielded achieved good results, the current situation of comprehensive control of diabetes is still not ideal, which suggests that the comprehensive control of patients is affected by multiple factors. Exploring the influencing factors in managing the chronic course of type 2 diabetes and the relationship between them is the basis of accurate individualized nursing for patients with diabetes. Some studies have shown that the economic level of patients with T2DM affects blood glucose control, and the blood glucose level of patients with high economic levels is well controlled[5, 6]. China is a country that faces unbalanced economic development with a large number of diabetes patients, and as the

current prevalence rate is high at 11.2%[7], the prevalence rate of chronic and severe diseases among low-income people in China is also at a high level. Therefore, we focused on the current situation of comprehensive metabolic control and all-cause analysis of the influencing factors of blood glucose control in type 2 diabetes with a large proportion of low-income people in China. Achieving effective management of this population is important not only for promoting the standard rate of this population but also for preventing complications. It is also important for the promotion of socialist harmony and the prosperity of the country. This study takes the seven dimensions of the comprehensive management of diabetes in 2016 as the framework and uses the Chinese version of the Diabetes Distress Scale (DDS) and the Diabetes Knowledge and Self-Management Behavior Scale to examine the current situation of comprehensive metabolic control among low-income people with type 2 diabetes on the following dimensions: body, mind and diabetes management. Comprehensive related research was also conducted in order to develop a model to predict blood glucose control and to identify all-cause factors that influence blood glucose control. this study aims to determine the influencing factors of patients' daily blood glucose control and the relationship between them to provide a basis for proper nursing care for low-income patients with type 2 diabetes.

Materials And Methods

Subjects of study

Four hundred and sixty-two outpatients and inpatients with type 2 diabetes were recruited by random sampling.

The inclusion criteria were as follows: patients with type 2 diabetes who meet the diagnostic criteria for diabetes set forth by the WHO in 1999; patients with type 2 diabetes whose per capital monthly income is less than RMB 2000; provided informed consent and voluntary participated; clear awareness and accurately expressed their will; no previous history of mental illness, no history of alcohol and drug dependence; age over 55 years old; score ≥ 7 on a short intelligence test.

The exclusion criteria were as follows: consciousness is unclear or does not cooperate; language expression is unclear; patients with malignant tumors or other serious diseases; patients with mental illness, hearing impairment or visual impairment.

Survey methods

In the form of the questionnaire, a survey was administered to outpatients and inpatients with type 2 diabetes who met the criteria of nanoplatoon. Before the survey, the purpose and significance of this study were explained, and after obtaining consent, the subjects filled out the questionnaire by themselves. For the patients who could not fill out the questionnaire for various reasons, the researchers read the questionnaire to them and filled it out according to the subjects' answers. A total of 480 questionnaires were sent out; 480 were recovered, and 462 were valid, yielding an effective recovery rate of 96.3%.

The following clinical biochemical indicators were collected: height, weight, BMI, blood pressure, blood lipids, glycosylated hemoglobin and others.

Research tools

The research group Diabetes General data questionnaire was used and was designed based on an extensive reading of relevant literature, guidelines and the opinions of clinical and scientific experts. The contents included the general data of the subjects, the disease data and the knowledge of self-management. The questionnaire also assess glycosylated hemoglobin, blood pressure, blood lipids, BMI and other indexes in patients with type 2 diabetes.

The psychological status of patients with diabetes was evaluated by the Chinese version of the Diabetes Distress Scale (DDS), which was developed by Polonsky[8,9] et al in 2005 and translated into Chinese by Yang Qing et al in 2010. The scale includes 4 dimensions and 17 items. Each item is scored on a scale ranging from 1 to 6, where no problem is scored as 1, minor problem is scored as 2, moderate problem is scored as 3, slightly serious problem is scored as 4, serious problem is scored as 5, severe problem is scored as 6. The maximum total score was 112. Higher scores indicated more severe psychological pain associated with diabetes. An average DDS score ≥ 3 is considered to indicate more than moderate pain and needs clinical attention.

Regarding the Diabetes Knowledge and Self-Management Behavior Scale, which was developed by Chen Wenzheng et al., the Cronbach's α of internal consistency of the total scale was 0.975, and the Cronbach's α of the knowledge subscale and behavior subscale were 0.967 and 0.929, respectively. The test-retest reliability coefficient of the total scale was 0.906, and the test-retest reliability coefficients of the knowledge and behavior subscales were 0.896 and 0.879, respectively. There were 35 items on the total scale, including 20 items on the knowledge scale, containing three dimensions: daily nursing knowledge related to diabetes, nursing knowledge related to hyperglycemia and hypoglycemia, and comprehensive nursing knowledge related to diabetes. There were fifteen items on the behavior scale contained three dimensions: behaviors related to diabetic treatment compliance, behaviors related to diabetic falls, and behaviors related to diabetic medication compliance. Each item was scored on a scale ranging from 1 to 5, where a score of 1 represented no knowledge, a score of 2 represented knowing one, a score of 3 represented knowing two, a score of 4 represented knowing three, and a score of 5 represented knowing four. The maximum total score was 175. Higher scores indicate a higher level of knowledge and behavioral ability related to diabetes. The score must reach 60 percent, or 105 to pass.

Statistical Analysis

The database was managed using Epidata3.1. All data were recorded by two individuals: one person recorded the data, and the other person double-checked. SPSS22.0 was used for statistical analysis. The quantitative data were expressed as mean \pm standard deviation, and the qualitative data were expressed as frequency and percentage (%). The correlation analysis was carried out by Pearson correlation analysis, and the regression analysis was carried out by multiple linear regression analysis. A P value < 0.05 was considered statistically significant.

Results

General data and disease data of low-income patients with type 2 diabetes

The general and disease data of patients with type 2 diabetes mellitus showed that low-income people with type 2 diabetes also had low levels of educational: the vast majority of patients' educational level was below the senior high school level. Their awareness of participating in health education was not so high, and only 30% of

the patients participated in the survey. The survey also revealed that most of the patients' personal income came from their children and that they worked independently; the proportion of patients with pensions was less than 18%. The subjects had a long course of diabetes and were older. Among the 229 patients who had been diagnosed for more than 10 years, most experienced complications, the most common of which was peripheral vascular diseases. The specific results are shown in Table 1.

Control status of blood glucose, blood pressure, blood lipids and BMI

The results of the study for the control status of blood glucose, blood pressure, blood lipids and BMI in patients with type 2 diabetes showed that the success rate of glycosylated hemoglobin in low-income patients with type 2 diabetes was 26.41%, which was slightly lower than that of NEW2D[10]. The proportion of patients with a blood pressure that met the standard was only 20.39%; the prevalence of dyslipidemia was as high as 82%, and only 18% of the patients reached the standard levels of TC, TG, HDL and LDL. The standard of comprehensive metabolism was even lower; only 5 patients had blood sugar, blood pressure and blood lipid levels that all reached the standard, accounting for 1.1% of the total sample. The specific results are shown in Table 2.

Current status of self-management knowledge and behavior

The study of the status of self-management knowledge behavior in patients with type 2 diabetes showed that the self-management knowledge and self-management behavior of low-income patients with type 2 diabetes were not high, and the average score of the behavior scale was higher than that of the knowledge scale. On the knowledge scale, the dimension with the lowest average score was daily nursing knowledge related to diabetes, and the dimension with the highest score was comprehensive nursing knowledge related to diabetes. On the behavior scale, the dimension with the lowest average score was the behavior related to treatment compliance, and the dimension with the highest average score was the behavior related to medication compliance. The specific results are shown in Table 3.

Total score and scores for each dimension of the DDS

Regarding the total score and the scores for each dimension the Chinese version of the Diabetes Distress Scale (DDS), the results showed that the proportion of low-income patients with type 2 diabetes who had psychological pain was as high as 50.43%. Emotional burden and pain related to the life law had the highest scores and were the main source of psychological pain. The specific results are shown in Table 4.

Correlations among HbA1c, the Diabetes Knowledge and Self-Management Behavior Scale and the DDS

To analyze the correlations among HbA1c levels, the Chinese version of the Diabetes Distress Scale (DDS) and the Diabetes Knowledge and Self-Management Behavior Scale Pearson's correlation analysis was conducted. The results showed that the scores of the Chinese version of the Diabetic Distress scale (DDS) were significantly negatively correlated with the scores of the knowledge scale, behavior scale and the Diabetes Knowledge and Self-Management Behavior Scale. HbA1c was significantly negatively correlated with the knowledge scale, behavior scale and the Diabetes Knowledge and Self-Management Behavior Scale and significantly positively correlated with the Diabetic Distress Scale (DDS). The specific results are shown in Table 5.

Multiple linear regression analysis of blood glucose control

Stepwise multiple linear regression was used to analyze the factors affecting blood glucose control. For multiclassification variables, dummy variables were first set and then included in the regression model, $\alpha_{in} = 0.05$, $\alpha_{out} = 0.10$. The following factors were included in the model: gender, age, complications, comprehensive management, the total score and scores on each dimension of the DDS, the total score of Diabetes Knowledge and Self-Management Behavior Scale and scores for each subscale. The results showed that self-management ability, interpersonal-related pain, time to diabetes diagnosis, age, diabetic nephropathy, emotional burden, sex and smoking were statistically significant factors affecting HbA1c in low-income patients with type 2 diabetes, which jointly explained 47.2% of the changes in HbA1c. The specific results are shown in Table 6.

Discussion

The study results regarding comprehensive metabolic control among low-income patients with type 2 diabetes mellitus in this specific study area were similar to those of the NEW2D, 3B study [10,11]. Patients with type 2 diabetes are at high risk of cardiovascular disease because they have multiple cardiovascular independence risk factors. The results of this study are shown in Table 2. The blood glucose reaching rate was low, and the comprehensive reaching rate was even lower. Among the 462 patients, only 5 patients reached the standard of blood glucose, blood pressure and blood lipids, accounting for 1.1%, which was much lower than 5.6% of the 3B study [11]. The comprehensive metabolic out-of-control state is a high-risk factor for diabetic complications [12,13], and diabetic complications affect the quality of life of patients and lead to a sharp increase in economic burden. Compared with the economic burden brought to this population by standardized treatment to the early stage of diabetic complications, the economic burden of diabetic complications is more difficult for this population to bear [14]. Therefore, it is important to work together to promote comprehensive metabolic control among these patients at the policy level, medical and health level, and family and personal level. This would contribute to the tertiary prevention of diabetes and prevent or delay the progress of complications, thus reducing the economic burden of medical insurance and families.

To analyze the current situation of self-management knowledge and behavior in low-income patients with type 2 diabetes, previous research shows that the level of self-management knowledge and behavior of low-income patients with type 2 diabetes is low, and the current survey results are similar [15]. Some investigations have found that [16] there is a strong association between low income and low education level. This is similar to the baseline data investigated in this study: patients had low levels of education, poor health awareness, and a lack of access to health information. This study suggests that the success rate of the Diabetes Knowledge and Self-Management Behavior Scale is 22.5%, and the overall average level is not up to standard. The patient's behavior scale score is higher than that of the knowledge scale, which suggests that the patient can actively face diabetes, but the lack of diabetes self-management knowledge directly affects their behavior, and the patient's treatment-related compliance behavior still needs to be improved. The scale used in this study covers all the knowledge points of the self-management prescription for type 2 diabetes in China, and the purpose of the accurate evaluation is to enter the natural environment of patients with different backgrounds, help them overcome difficulties in daily life, improve self-management ability, and achieve effective management. This concept is consistent with the method advocated by the "Chinese expert consensus on self-Management of Type 2 Diabetes Mellitus". According to the evaluation scale, we should carry out proper individual education to

promote their self-management ability. Dynamic and continuous management of patients is a management model that can be further used by both nurses and patients in the future.

Regarding the study of psychological pain related to diabetes in low-income patients with type 2 diabetes, the results show that the vast majority of diabetic patients have diabetes-related pain: 50.43% of diabetic patients have slight pain, and 23.38% of diabetic patients have moderate or above pain, mainly related to the emotional burden and pain related to the law of life. Studies have shown that [17-19]health education and self-management support can effectively improve diabetes-related pain in patients with diabetes. The latest research from Harvard Medical School in the United States shows that impaired insulin signals in the brain may have adverse effects on cognition, emotion and metabolism, which suggests that actively carrying out targeted and effective health education and self-management support and promoting the metabolic standards of patients is not only a necessary way to prevent and delay the complications of diabetes but also an effective way to improve their psychological pain.

The results of this study for the relationship among blood glucose control and Diabetes Knowledge and Self-Management Behavior Scale and Chinese version of Diabetes Distress scale ((DDS) (such as Tables 5) show that glycosylated hemoglobin is negatively correlated with the Diabetes Knowledge and Self-Management Behavior Scale score, and the differences are statistically significant, which suggests that the better the knowledge of diabetes, the higher the self-management behavior and the better the blood glucose control. The results are consistent with other previous findings [20,21]. HbA1c was significantly positively correlated with the score of the Chinese version of the Diabetes Distress scale, suggesting that worse blood glucose control is associated with a higher the degree of diabetes-related psychological pain. There was a significant negative correlation between the Chinese version of the Diabetes Distress Scale and the Diabetes Knowledge and Self-Management Behavior Scale scores, suggesting that when patients have self-management knowledge and behavior levels, their blood glucose control may be better, and the corresponding degree of psychological pain may be lower.

The multiple linear regression analysis of glycosylated hemoglobin in low-income patients with type 2 diabetes examined the scores of the Diabetes Knowledge and Self-Management Behavior Scale, the scores of the Chinese version of Diabetes Distress scale, and the demographic data of patients, including comprehensive treatment measures and complications of patients with diabetes. The results show that the scores of the Diabetes Knowledge and Self-Management Behavior Scale, the pain related to interpersonal relationships in the Chinese version of Diabetes Distress scale, age, diabetic nephropathy, smoking and gender are the main factors that affect the control of blood glucose in this group of patients with type 2 diabetes. Among these factors, the most important are the scores on the Diabetes Knowledge and Self-Management Behavior Scale and the pain related to interpersonal relationship in the Chinese version of Diabetes Distress scale, which is consistent with the results of related studies[21,22]. In patients with diabetic nephropathy, glycosylated hemoglobin is lower because the glomerular filtration rate is lower, which affects drug metabolism. HbA1c is positively correlated with the course of disease and "emotion burden" on the Chinese version of the Diabetes Distress scale, suggesting that the control of blood sugar in patients with chronic disease is not better managed with the increase in the course of the disease but worsens further. The loss of control of blood sugar may cause diabetes-related pain emotion, which may be related to the lack of management knowledge. Whether the active construction of the comanagement model of nurses and patients in chronic management can improve the

above situation can be further discussed in the following study. Smoking is an independent risk factor for cardiovascular disease and increases the risk of complications[23,24]. The study suggests that the control of glycosylated hemoglobin will benefit at the same time when actively doing an excellent job in smoking cessation education for low-income patients with type 2 diabetes, which may explain how previous smokers who have quit have more substantial health management knowledge and compliance with diabetes. The results also showed that the control of HbA1c in females was better than that in males, which suggests that further analysis of male and female patients should be conducted with special consideration of the control of blood glucose in male patients. The above results suggest that it is important to integrate medical and information resources, develop appropriate individualized education and management modes for this group, and encourage patients and their caregivers to actively learn diabetes management knowledge. These steps will not only reduce the degree of pain related to diabetes but also delay and prevent the complications of diabetes.

Conclusions

Low-income patients with type 2 diabetes have a low comprehensive metabolic compliance rate, a lack of knowledge of diabetes self-management and low levels of self-management. Diabetes Knowledge and Self-Management Behavior Scale scores are the main factors that influence glycosylated hemoglobin control, which suggests that medical staff at all levels should implement effective and precise treatment and education to make effective intervention plans according to the local situation and the actual situation of patients. This will realize the transformation research of effective management and thus promote comprehensive metabolic control among low-income patients with type 2 diabetes to enable them to reach standard levels and prevent the occurrence of diabetes complications.

Abbreviations

BMI: body mass index; DBP: diastolic blood pressure; SBP: systolic blood pressure; TC: total cholesterol; TG: triglycerides; HDL: high-density lipoprotein cholesterol; LDL: low-density lipoprotein cholesterol; HbA1c: glycosylated hemoglobin

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Second Affiliated Hospital of Shantou University Medical College according to the Council for International Organizations of Medical Sciences. Written informed consent was obtained from all participants.

Consent for publication

Not applicable

Availability of data and materials

The data used to support the current study's findings are available from the corresponding author on request.

Competing Interests

The authors declare that there are no conflicts of interest regarding the publication of this article.

Funding Statement

This study was supported by the Key Laboratory of Diabetes Prevention and Treatment Open Research Foundation of Guangdong Province, China (grant number: A3220).

Authors' contributions

HUANG Fuhua, DONG Lili and WENG Xiaoxu: Data Collection

SU Jing: Manuscript Preparation

CHEN Yanzhu: Literature Search

LIN Xinyi: Statistical Analysis

HONG Lvrong: Data Interpretation

CHEN Wenzhuan: Study Design

Acknowledgments

The author would like to thank [Nature Research Editing Service](#) for technical language editing of the manuscript.

References

1 Zhou B, Lu Y, Hajifathalian K, Bentham J, Ezzati M: Supplementary Material: Worldwide trends in diabetes since 1980: A pooled analysis of 751 population-based studies with 4.4 million participants. *the Lancet* 04/2016; 387(10027). 2016

2 Gaede P, Lund-Andersen H, Parving HH: Effect of a multifactorial intervention on mortality in type II diabetes. *J VASC SURG* 2008

3 Tang TS, Sohal PS, Garg AK: Rethinking peer support for diabetes in Vancouver's South-Asian community: A feasibility study. *Diabet Med* 2015;32:1077-1084.

4 Kuhnke JL, Rosenthal S: Peer-to-Peer education: The PEP talk: Diabetes, healthy feet and you program in Canada. *Journal of wound, ostomy, and continence nursing: official publication of The Wound, Ostomy and Continence Nurses Society / WOCN* 2015;42:321-323.

5 Robbins, Jessica M, Vaccarino, Viola, Zhang H, Kasl, Stanislav V: Socioeconomic status and type 2 diabetes in African American and Non-Hispanic white women and men: Evidence from the third national health and nutrition examination survey. *AM J PUBLIC HEALTH* 2001

- 6 Booth GL, Hux JE: Relationship between avoidable hospitalizations for diabetes mellitus and income level. *Archives of Internal Medicine* 2003;163:101.
- 7 Li Y, Teng D, Shi X, Qin G, Qin Y, Quan H, Shi B, Sun H, Ba J, Chen B, Du J, He L, Lai X, Li Y, Chi H, Liao E, Liu C, Liu L, Tang X, Tong N, Wang G, Zhang JA, Wang Y, Xue Y, Yan L, Yang J, Yang L, Yao Y, Ye Z, Zhang Q, Zhang L, Zhu J, Zhu M, Ning G, Mu Y, Zhao J, Teng W, Shan Z: Prevalence of diabetes recorded in mainland China using 2018 diagnostic criteria from the American Diabetes Association: National cross sectional study. *BMJ* 2020;369:m997.
- 8 Polonsky, William, H., Fisher, Lawrence, Earles, Jay, Dudl, R., James: Assessing psychosocial distress in diabetes. *DIABETES CARE* 2005
- 9 Sigurdardottir AK, Benediktsson R: Reliability and validity of the Icelandic version of the problem area in diabetes (PAID) scale. *INT J NURS STUD* 2008;45:526-533.
- 10 Cai X, Hu D, Pan C, Li G, Ji L: The risk factors of glycemic control, blood pressure control, lipid control in Chinese patients with newly diagnosed type 2 diabetes _ a nationwide prospective cohort study. *entific Reports* 2019;9:7709.
- 11 Ji L, Hu D, Pan C, Weng J, Yong H, Ma C, Mu Y, Hao C, Ji Q, Ran X: Primacy of 3B approach to control cardiovascular risk in type 2 diabetes. *AM J MED* 2012
- 12 Ji L, Hu D, Pan C, Weng J, Huo Y, Ma C, Mu Y, Hao C, Ji Q, Ran X: Primacy of the 3B approach to control risk factors for cardiovascular disease in type 2 diabetes patients. *AM J MED* 2013;126:911-925.
- 13 Ray KK, Seshasai S, Wijesuriya S, Sivakumaran R, Sattar N: Effect of intensive control of glucose on cardiovascular outcomes and death in patients with diabetes mellitus: A meta-analysis of randomised controlled trials. *LANCET* 2009;373:1765-1772.
- 14 Jönsson B: Revealing the cost of Type II diabetes in Europe. *DIABETOLOGIA* 2002;45:S5-S12.
- 15 Chen W: Development and Validation of a scale to assess Knowledge, self care management ability related to Diabetes in Chinese population. Shantou University, 2017.
- 16 Socioeconomic status and risk of cardiovascular disease in 20 low-income, middle-income, and high-income countries: The Prospective Urban Rural Epidemiologic (PURE) study. *LANCET GLOB HEALTH* 2019
- 17 Hermanns N, Kulzer B, Maier B, Mahr M, Haak T: The effect of an education programme (MEDIAS 2 ICT) involving intensive insulin treatment for people with type 2 diabetes. *Patient Education & Counseling* 2012;86:226-232.
- 18 Margaret, A., Powers, Joan, Bardsley, Marjorie, Cypress, Paulina, Duker, Martha: Diabetes Self-management Education and Support in Type 2 Diabetes. *The Diabetes Educator* 2017;43:40-53.
- 19 Cochran J, Conn VS: Meta-analysis of quality of life outcomes following diabetes self-management training. *The Diabetes Educator* 2008;34:815-823.

- 20 Norris SL, Engelgau MM, Narayan KV: Effectiveness of Self-Management Training in Type 2 Diabetes: A systematic review of randomized controlled trials. *DIABETES CARE* 2001;24:561-587.
- 21 Fatema K, Hossain S, Natasha K, Chowdhury HA, Ali L: Knowledge attitude and practice regarding diabetes mellitus among Nondiabetic and diabetic study participants in Bangladesh. *BMC PUBLIC HEALTH* 2017;17:1-10.
- 22 Doyle, M., Cummings, Lesley, Lutes, Kerry, Littlewood, Emily, DiNatale, Bertha: Regimen-Related distress, medication adherence, and glycemic control in rural african american women with type 2 diabetes mellitus. *ANN PHARMACOTHER* 2014;48:970-977.
- 23 Zheng Y, Ley SH, Hu FB: Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *NAT REV ENDOCRINOL* 2017
- 24 International C: The health consequences of smoking—50 years of progress: A report of the surgeon general., United States. Public Health Service. Office of the Surgeon General., 2014.

Tables

Table 1 General data and disease data of low-income patients with type 2 diabetes (n=462)

Factors		Cases	HbA1c(%)
Way of treatment	Inpatient	343	8.84±2.13
	Outpatients	119	7.55±1.54
Sex	Man	220	8.61±2.18
	Woman	242	8.41±1.96
Education	Bachelor degree or above	5	9.20±1.91
	Junior college	20	7.82±2.14
	High school or secondary school	66	8.37±2.03
	Junior high school	84	8.55±2.28
	Primary school	175	8.46±2.05
	Illiteracy	112	8.72±1.95
Personal economy	pension	81	7.98±1.72
	Child support	212	8.54±2.12
	Work autonomously	169	8.72±2.13
High blood pressure	No	309	8.73±2.15
	Yes	153	8.05±1.82
Diabetic nephropathy	No	364	8.61±2.04
	Yes	98	8.13±2.11
Diabetic fundus disease	No	288	8.46±2.12
	Yes	174	8.59±1.99
History of coronary heart disease	No	441	8.55±2.08
	Yes	21	7.50±1.52
History of cardiac insufficiency	No	447	8.54±2.08
	Yes	15	7.63±1.65
History of diabetic foot	No	404	8.43±2.01
	Yes	58	9.04±2.38
History of peripheral vascular disease in diabetes mellitus	No	254	8.31±2.01
	Yes	208	8.74±2.12
Medication method	Oral hypoglycemic drugs	263	8.31±2.12
	Insulin injection	56	8.78±2.09
	Oral medicine + insulin	99	8.29±1.52

	No	44	9.80±2.32
Whether to participate in diabetes knowledge training	No	320	8.80±2.10
	Yes	142	7.85±1.83
Smoking	Yes	114	8.83±2.26
	No	315	8.40±2.00
	Quit smoking	33	8.38±1.90
Drinking	Yes	66	8.69±2.24
	No	384	8.47±2.04
	Quit drinking	12	8.51±2.15
Diet therapy to control blood sugar	Yes	346	8.12±1.92
	No	116	9.67±2.08
Exercise therapy to control blood sugar	Yes	348	8.27±2.00
	No	114	9.21±2.11
Drug therapy to control blood sugar	Yes	429	8.39±2.02
	No	33	9.96±2.22
Age (years)	18-40	23	9.42±2.75
	41-60	163	8.61±2.15
	>=61	276	8.37±1.93
Time to Diabetes Diagnosis (years)	<1	64	9.00±2.58
	1-5	74	8.07±1.96
	5-10	95	7.96±1.81
	>=10	229	8.74±1.98

Table 2 Control status of blood glucose, blood pressure, blood lipids and BMI in low-income patients with type 2 diabetes (n=462)

Project		Average	Control objectives	Success rate [%]
HbA1c(%)		8.72±2.32	<7.0	26.41
Systolic blood pressure[mmHg]		142.09±23.34	<130/80	20.39
Diastolic pressure[mmHg]		80.35±13.44		
Total cholesterol(mmol/L)		5.08±1.64	<4.5	38.64
Triglycerides(mmol/L)		2.20±2.60	<1.7	54.37
High density lipoprotein [mmol/L]	Males	1.06±0.31	>1.0	55.2
	Females	1.21±0.38	>1.3	36.67
Low-density lipoprotein [mmol/L]	Without ASCVD	3.25±1.31	<2.6	5.7
	With ASCVD	2.78±0.95	<1.8	52
BMI(kg/m ²)		23.33±3.44	<24	58.44

Table 3 Current status of self-management knowledge and behavior in low-income patients with type 2 diabetes (n=462)

Project	Number of entries	Minimum	Maximum	Average
Knowledge behavior ability scale	35	49	173	89.57±19.00
Knowledge scale	20	24	98	44.52±10.93
Daily nursing knowledge related to diabetes	10	10	50	17.53±5.75
Nursing knowledge related to hyperglycemia and hypoglycemia	5	5	25	11.25±3.07
Comprehensive nursing knowledge related to diabetes	5	6	25	15.73±3.62
Behavior scale	15	24	75	45.05±9.32
Behaviors related to diabetes treatment compliance	10	13	45	25.60±6.15
Behaviors related to diabetic falls	3	5	15	11.21±1.97
Behaviors related to medication compliance	2	2	10	7.78±2.24

Table 4 Total DDS score and each dimension score in low-income patients with type 2 diabetes mellitus (n=462)

Project	Number of entries	Mini-mum	Maxi-mum	Avera-ge	Pain degree distribution		
					No pain	Slight pain	Moderate or above pain
Total score	17	17	80	41.72±12.35	121□26.19%□	233□50.43%□	108□23.38%□
Pain associated with doctors	4	4	18	5.54±1.87	429□92.86%□	29□6.28%□	4□0.87%□
Emotional burden	5	5	26	15.18±4.57	45□9.74%□	161□34.85%□	256□55.41%□
Pain related to life law	5	5	27	14.06±4.83	71□15.38%□	205□44.37%□	186□40.26%□
Pain related to interpersonal relationships	3	3	15	6.94±2.30	90□19.48%□	260□56.28%□	112□24.42%□

Table 5 Correlation among HbA1c, the Diabetes Knowledge and Self-Management Behavior Scale, and the DDS (r value)

Project	HbA1c	DDS	Knowledge Scale	Behavior Scale	Diabetes Knowledge and Self-Management Behavior Scale
HbA1c	1	0.43**	-0.58**	-0.63**	-0.65**
DDS		1	-0.68**	-0.69**	-0.73**

Note: * * when the confidence level (both sides) is 0.01, the correlation is significant.

Table 6 Multiple linear regression analysis of blood glucose control (HbA1c) in low-income patients with type 2 diabetes (n=462)

Variable	Regression coefficient (β)	Standard partial regression coefficient (β')	t	P value
total score of Diabetes Knowledge and Self-Management Behavior Scale	-0.078	-0.716	-14.985	0.000
Pain related to interpersonal relationships	-0.192	-0.213	-4.039	0.000
time to Diabetes Diagnosis	0.005	0.161	4.297	0.000
Age	-0.021	-0.117	-3.185	0.002
Diabetic nephropathy	-0.541	-0.107	-2.969	0.003
Emotional burden	0.061	0.135	2.515	0.012
Sex	-0.385	-0.093	-2.494	0.013
Smoking	0.285	-0.074	1.979	0.048

Note: whether diabetic nephropathy is diagnosed is assigned 0 = No, 1 = Yes; whether smoking is 0 = No, 1 = Yes; Sex 1 = male, 2 = female; $R^2 = 0.472$, $F = 50.530$, $p < 0.01$

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Researchtools.doc](#)