Key Factors of Blood Glucose Control for Korean People with Diabetes

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Abstract

Objectives: The purpose of this study was to determine the differences between good and poor glucose control groups, and as a result, to identify the factors affecting glycemic control. **Methods/Statistical Analysis:** This was a descriptive survey study wherein the subjects were adults with diabetes. Based on blood test results from 267 subjects, the participants were divided into two groups: good and poor glucose control. To measure the factors affecting glucose control, the demographics, clinical factors, and health-related behaviors were surveyed using a questionnaire. Real number, percentage, mean, standard deviation, Pearson's correlation, and hierarchical logistic regression were used to obtain glucose control characteristics. **Findings:** The American Diabetes Association has recommended that Hemoglobin A1c levels be below 7.5% in healthy adults with a long life expectancy. We used this recommended level as the criterion for our study. In the logistic regression analysis, when all variables were controlled for, the following factors were identified as significantly affecting glucose control. This study found that diabetic education, smoking, and alcohol consumption did not significantly affect glucose control. **Improvement/Applications:** Physicians and nurses should promote effective glucose control in patients with diabetes through individualized intervention methods; in this way, the patients' glucose control is maintained at an adequate level.

Keywords: Diabetes, Factor, Glucose Control, Hba1c, Hierarchical Logistic Regression

1. Introduction

The purpose of this study was to gain an understanding of the extent of glycemic control in patients with diabetes and to determine the differences between good and poor glycemic control groups, and as a result, to identify the factors affecting glycemic control. The specific objectives of this study were as follows: examine the demographic, behavioral, and clinical characteristics of the study participants; determine whether there are any differences between the good and poor glycemic control groups in terms of these characteristics; and identify the factors that affect glycemic control in the participants. The American Diabetes Association has recommended a level of HbA1c below 7.5% for healthy adults with a long life expectancy¹. However, few studies used 7.5% HbA1c as the criterion to classify patients with diabetes into glycemic control and non-glycemic control groups. Based on this recommendation, this study aimed to understand the characteristics associated with the glycemic control group, as well as to identify the factors that affect glycemic control in patients with diabetes, and to provide fundamental data required to develop customized intervention programs based on the particular extent of glycemic control in individual patients.

Diabetes is a chronic disease that is characterized by impaired blood glucose and can lead to disturbances in various organs². Diabetes morbidity and mortality has been increasing and it is recognized as a major social problem. In fact, diabetes is becoming more common in the United States. From 1980 through 2014, the number of American adults aged 18 years or older with diagnosed diabetes has almost quadrupled (from 5.5 million to 21.9 million)³. In Korea in 2014, an estimated 11.1% of people 30 years of age and older had diabetes⁴, with the disease being the 6th highest cause of mortality⁵. Additionally, the average http:// academic.naver.com/view.nhn?doc_id=177261545&dir_ id=1&field=0&unFold=false&gk_adt=0&sort=0&qv t=1&query=diabetes%20complication%20cost&gk_ qvt=0&citedSearch=false&page.page=1&ndsCategory Id=10636annual direct medical cost in patients without complications was 351,660 won in 2011. The average http:// academic.naver.com/view.nhn?doc_id=177261545&dir_ id=1&field=0&unFold=false&gk_adt=0&sort=0&qv t=1&query=diabetes%20complication%20cost&gk_ qvt=0&citedSearch=false&page.page=1&ndsCategor yId=10636annual direct medical cost in patients who had micro-vascular complications such as retinopathy, nephropathy or neuropathy was 506,160 won, 1.4 times higher than the cost without diabetes complications. In those who had macro-vascular complications such as myocardial infarction, cerebro-vascular accident, or end-stage renal disease, the cost was 1,362,928 won, 3.8 times higher than that for patients without diabetes complications⁶. HbA1c is one of the most important parameters related to patient outcomes in those with diabetes. Intensive HbA1c control can reduce eye complication up to 76%, kidney disease up to 50%, nerve disease up to 60%, cardiovascular disease events up to 42%, and death from cardiovascular causes up to 57%7. Hence, discussion has been raised regarding the need for thorough planned diabetes management. Glycemic control includes taking medications, monitoring blood control level, exercising regularly, and following a diabetes-specific diet8. Studies on glycemic control in patients with diabetes have been conducted from various angles and approaches, including self-management, psychological wellbeing, and development of educational programs9-11. In studies that examined patients with diabetes practicing glycemic control, the following were identified as affecting factors: economic status, sleeping hours, depression, disease duration, and age¹²⁻¹⁵.

2. Research Methods

2.1 Study Design

This descriptive survey study aimed to determine the state of glycemic control in patients with diabetes and to identify the factors that affect their glycemic control.

2.2 Study Participants

The participants of this study were adult patients with diabetes over the age of 20 receiving treatment for over 3 months at the endocrinology department of University hospital as outpatients. They agreed to participate in this study and to complete the questionnaire. Of 340 surveys, data from 267 (78.5%) were used; 37 surveys were incompletely filled and 36 subjects did not provide blood samples, so these subjects were excluded from study.

2.3 Variables

To measure the factors affecting blood sugar control, demographics, clinical factors, and health-related behaviors were surveyed using a questionnaire that we developed by reviewing the literature. The items related to demographics included sex, age, and education level. The level of education comprised the total number of years in school and the most recent level of education completed. The clinical factors included diagnosis of depression, admissions to hospitals or visits to emergency rooms within the past 6 months, education on diabetes, and experience of hypoglycemia. The available answer choices were "yes" or "no". For the participants' subjective assessment of their health, a 5-point scale was used, with choices ranging from "extremely good" to "extremely bad". With respect to health-related behaviors, items such as smoking, exercise, and diet consisted of "yes" or "no" answers while for assessing drinking, a 6-point scale was used, from "none" to "drink daily". The HbA1c test was done through the medical laboratory for outpatients at C Hospital according to the hospital's own test protocols.

2.4 Data Analysis

Based on blood test results, the participants were divided into good glycemic control and poor glycemic control groups using 7.5% HbA1c as the standard. Real number, percentage, mean, and standard deviation were obtained for demographic and glycemic control characteristics. A t-test was used to examine how glycemic control varied with demographic characteristics. Pearson's correlation was used to examine the relationship between demographic characteristics and glycemic control. Hierarchical logistic regression was used to determine the predictors of glycemic control.

2.5 Ethical Consideration

The Institutional Review Board (IRB No. 2-1046881-A-N-01-201410-HR-046) by C University approved all study procedures.

3. Results

3.1 Differences in Demographic Factors among Glycemic Control Groups

As shown in Table 1, a total of 267 patients with diabetes participated in this study. Of those, 162 (62%) had HbA1c below 7.5%, while 100 (39%) had HbA1c above 7.5%. Glycemic control was not affected significantly by age, sex, or level of education.

3.2 Differences in Clinical Factors among Glycemic Control Groups

As shown in Table 2, experience of hypoglycemia and subjective health were significantly correlated with the participants' glycemic control. Blood glucose increased when the participants developed hypoglycemia at a higher rate. On the other hand, blood glucose levels increased when the participants assessed their health as more favorable.

3.3 Differences in Health-Related Behavior Factors among Glycemic Control Groups

As shown in Table 3 and in contrast to findings of previous studies, this study determined that there were no statistically significant correlations between glycemic control and smoking, exercise, drinking, or diabetic diet.

3.4 The Key Factors of Glycemic Control

As shown in Table 4, a three-step hierarchical logistic regression was used in order to identify significant factors affecting glycemic control. The first step examined the demographic characteristics (i.e., age, sex, and level of education). The second step examined

 Table 1. Differences in demographic factors between controlled and uncontrolled groups (N=267).

Variable		≤ HbA1c 7.5%	≥ HbA1c 7.5%	χ ² or t (p)
		n or Mean (% or \pm SD)	n or Mean (% or \pm SD)	-
Gender	Male Female	95 (58.6) 67 (41.4)	54 (51.4) 51 (48.6)	1.344 (.246)
Age		59.98 (10.86)	59.60 (14.34)	.223 (.824)
Education level	None \leq Middle	6 (3.7) 49 (30.2) 107 (66.0)	6 (5.7) 37 (35.2) 62 (59.0)	1.559 (.459)
	$school \ge High \ school$			

Table 2. Differences in clinical factors between controlled and uncontrolled groups.

Variable		< HbA1c 7.5%	≥ HbA1c 7.5%	χ^2 or t (p)
		n or Mean (% or \pm SD)	n or Mean (% or ± SD)	
Depression	Yes No	142 (87.7) 20 (12.3)	97 (92.4) 8 (7.6)	1.516 (.218)
Experience of admission with 6 month	Yes No	21 (13.0) 141 (87.0)	18 (17.1) 87 (82.9)	.892 (.345)
Experience of ER with 6 month	Yes No	10 (6.2) 152 (93.8)	12 (11.4) 93 (88.6)	2.328 (.127)
Experience of hypoglycemia	Yes No	77 (47.5) 85 (52.5)	69 (65.7) 36 (34.3)	8.500 (.004)
Experience of diabetic education	Yes No	77 (47.5) 85 (52.5)	51 (48.6) 54 (51.4)	.028 (.868)
Subjective health status	Range 1-5	2.95 (.85)	3.16 (.67)	-2.145 (.033)

 Table 3.
 Differences in health-related behavior factors between glycemic controlled and uncontrolled groups

Variable		< HbA1c 7.5%	≥ HbA1c 7.5%	χ ² or t (p)
		n or Mean (% or ± SD)	n or Mean (% or ± SD)	
Smoking	Yes No	25 (15.4) 137 (84.6)	20 (19.0) 85 (81.0)	.594 (.441)
Exercise	Yes No	111 (68.5) 51 (31.5)	64 (61.0) 41 (39.0)	1.615 (.204)
Drinking	Yes No	55 (34.0) 107 (66.0)	31 (29.5) 74 (70.5)	.572 (.450)
Diabetic diet	Yes No	71 (43.8) 91 (56.2)	57 (54.3) 48 (45.7)	2.792 (.095)

the clinical factors, while the third step examined health-related behavior (i.e., whether or not the participants engaged in smoking, drinking, exercise, or diabetic diet). In the first step, no demographic characteristics were found to affect glycemic control. In the second step, however, the prevalence of depression (OR = 2.629, 95% CI = 1.061-6.514) and experience of hypoglycemia (OR = 2.091, 95% CI = 1.203–3.634) were found to be related to glucose control after controlling for demographics. This can be interpreted as evidence that if participants had depression, it was 2.6 times more likely that they would experience uncontrolled glucose levels (HbA1c \geq 7.5%). Lastly, in the third step, health-related behaviors that included smoking, exercise, drinking, and diabetic diet were included in addition to Model 2. As a result of third step, the prevalence of depression (OR = 3.587, 95% CI = 1.379–9.331), experience of hypoglycemia (OR = 2.283, 95% CI = 1.287-4.049) and diabetic diet (OR = 2.114, 95% CI = 1.191-3.752) seemed to play a significant role in glucose control. Hence, it was 3.6 times more likely that patients would have an uncontrolled glucose status in the case where such patients had depression. Additionally, it was 2.3 times more likely that patients would have uncontrolled glucose levels in those who had experienced hypoglycemia. However, it was 2.1 times more likely that patients would have a controlled glucose status when following a diabetic diet.

4. Conclusion

The purpose of this study was to identify the factors that affect glycemic control in patients with diabetes in Korea - the risk factors for diabetes in the good glycemic control and the poor glycemic control groups. In doing so, the present study aimed to develop health improvement programs and intervention strategies for patients with diabetes. The American Diabetes Association has recommended that HbA1c levels be below 7.5% in healthy adults with a long life expectancy. According to recent research findings, a large proportion of patients with diabetes have poor glycemic control¹⁶. Although our findings did not suggest this, the difference is attributed to the fact that previous studies used a more stringent criterion of HbA1C below 7.0%. In the logistic regression analysis, when all variables were controlled for, the following factors were identified as significantly affecting glycemic control: depression, experience of hypoglycemia, and diabetic diet. The odds ratios were 3.58, 2.28 and 2.11, respectively. There is a statistically significant correlation between depression and high levels of HbA1c (OR = 3.587, 95% CI = 1.379–9.331). It has been confirmed by preliminary study that depression decreases glycemic control due to a depressed mood that interferes with selfcare, as an irregularity in the low-glycemic index diet, includes neglect of prescribed medication and lack of physical activity¹⁷. This study showed that the depression score is higher for those in the poor glycemic control group. In terms of depression and glucose control, further study will be necessary to determine whether the control of depression is meaningfully related to control of glucose level. The odds ratio was significantly high in the case of hypoglycemia and it seems that HbA1c is high because glucose control was not sufficient. It is confirmed at the study that patients with HbA1c>7% had a higher glycemic variability and that this criterion was not a reliable indicator of lower risk of hypoglycemia¹⁸. Therefore, the glucose control is necessary through diet therapy, drug therapy, blood glucose testing, and management of hypoglycemia and hyperglycemia. Furthermore, in this study, the findings are similar to preliminary studies¹⁹ that indicate that glucose is well controlled as a proper diet therapy by showing significant increase in odds ratio, which is under HbA1c levels of 7.5% (OR = 2.114, 95% CI = 1.191–3.752). Therefore, systematic and continuous nutrition training, the patient's willingness to control their glucose levels, the improvement of their diet lifestyle, and the removal of any obstacles for maintaining diet therapy are needed in order to implement a proper diet therapy. It has been reported that a patient's glycemic control can be improved in the long term through systematic education on selfmanagement²⁰. This study, however, found that diabetic education did not significantly affect glycemic control. It is highly likely that the inclusion of one-time sessions or general diabetes education influenced the finding. Smoking frequency, smoking duration, and HbA1c are reported to have dose-response relationships²¹. This study, however, found no significant correlation between smoking and glycemic control. In addition, alcohol is reported to have an adverse effect on glycemic control²²⁻²³. This study, however, found no significant correlation between alcohol consumption and glycemic control, as was the case with smoking. Therefore, future studies would be needed to subdivide the participants for analysis based on smoking frequency, smoking duration,

	/ariables			Mode					Model	2				Mod	el 3	
		â	SE	d	OR	95% CI	â	SE	d	OR	95% CI	a	SE	d	OR	95% CI
Demography	Gender	008	.011	.485	.992	.971- 1.014	008	.012	.463	.992	.969-1.014	006	.012	.584	.994	.971-1.017
	Age	.221	.262	.399	1.248	.746- 2.085	660.	.281	.724	1.104	.637-1.915	.228	.323	.480	1.256	.667-2.363
	Education level	.275	.239	.250	1.316	.824- 2.103	.171	.253	.499	1.186	.723-1.946	.030	.264	908	1.031	.615-1.728
Clinical factor	Depression						.967	.463	.037	2.629	1.061-6.514	1.277	.488	600.	3.587	1.379- 9.331
	Experience of admis- sion with 6 month						092	.412	0.824	.912	.406-2.048	143	.432	.741	.867	.371-2.023
	Experience of ER with 6 month						.214	.524	.683	1.238	.444-3.456	.139	.532	.793	1.150	.405-3.263
	Experience of hypo- glycemia						.738	.282	600.	2.091	1.203-3.634	.825	.292	.005	2.283	1.287- 4.049
	Experience of diabetic education						011	.273	696.	989.	.579-1.690	.039	.282	890.	1.040	.599-1.805
	Subjective health status						.312	.176	.076	1.367	.968-1.930	.350	.191	.067	1.419	.975-2.065
Health behavior	Smoking Exercise											.479 .474	.391 .303	.221 .118	1.615 1.606	.750-3.475 .886-2.910
	Drinking Diabetic diet											.010 .749	.338 .293	.976 .011	1.010 2.114	.521-1.958 1.1913.752

drinking amount, and drinking frequency. Depression, experience of hypoglycemia, and diabetic diet were found to significantly affect glycemic control. Based on the findings, physicians and nurses should promote effective glycemic control in patients with diabetes through individualized intervention methods so that the patients' glycemic control is maintained at an adequate level and does not diminish. This would improve the quality of life for such patients. In addition, diabetes should be properly diagnosed through national and workplace health checkups to reap the benefits of early treatment. Education and promotion of self-management and active glycemic control would also be required.

5. Limitations of the Study

This study used convenience sampling, which selects samples based on the study purpose. Therefore, it is difficult to generalize the findings of this study because the sample was not adequately representative.

6. Acknowledgments

This study was supported by the Mid-career Researcher Program through a National Research Foundation (NRF) grant funded by the Ministry of Education, Science and Technology (MEST) (NRF-2015R1A2A2A01002394).

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