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Original Article

The Association between Diabetes Education and Glucose Control in Diabetic Patients: Using the 2008 and 2013 Korea National Health and Nutrition Examination Survey

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ABSTRACT

This study was conducted to investigate the status of diabetes education in Korean diabetics and to analyze the association between blood sugar control and diabetes education. A total of 1,904 diabetic patients was classified into two groups (well-controlled group and uncontrolled group) using the 2008-2013 Korean National Health and Nutrition Survey data, and various variables were compared. Of the 1,904 patients, 15.9% had received diabetes education. The uncontrolled group had a low economic level, a high rate of drinking and obesity, and a low rate of moderate exercise. And the rate of drug treatment in the uncontrolled group was high, and the rate of education and nutrition education, and the total number of educations for diabetes were significantly lower than those in the control group. Factors affecting blood glucose control were analyzed drinking (odds ratio [OR], 1.34; 95% confidence interval [CI], 1.06–1.7), moderate exercise (OR, 0.45; 95% CI, 0.34–0.6), overweight and obesity (OR, 1.44; 95% CI, 1.17–1.78), duration of diagnosis (OR, 1.07; 95% CI, 1.05–1.08), treatment method (OR, 2.0; 95% CI, 1.45–2.77), nutritional education (OR, 0.62; 95% CI, 0.46–0.85), and education institution (OR, 0.71; 95% CI, 0.54–0.93). The results of this study support that education on lifestyle management, such as a balanced diet, regular exercise, and normal weight maintenance, is essential for blood glucose control, and patients with long-term treatment need cyclic and continuous education.

Keywords: Diabetes mellitus; Blood glucose; Educational status; Health communication

INTRODUCTION

The prevalence of diabetes is rapidly increasing worldwide [1]. Diabetes itself is not only a cause of death, but complications also increase the medical costs and reduce the quality of life [1,2]. Hence, it is essential to prevent the occurrence of complications and delay the progress rate through proper diabetes management [3]. Diabetes education is an important component after diagnosis, as managing diabetes requires self-management such as diet and exercise along with medication, and because education can acquire knowledge, skills and abilities [4,5]. Education has been reported to improve the patient's diabetes-related

Conflict of Interest
The authors declare that they have no competing interests.

knowledge and self-care behavior, improve clinical indicators, including hemoglobin A1c (HbA1c), and lower the incidence of chronic complications [6]. Education incurs costs, but consequently diabetes education has proven important by reporting cost-effectiveness [7]. Diabetes education programs are common in individual counseling or group lectures, and education and public relations activities such as open lectures, camps, and meal experiences are also used. Recently, mobile-based application devices provide a variety of information [8]. However, the most important aspect of diabetes education is the mutual trust between patients and educators, and the provision of accurate and professional information [9]. To this end, domestic and foreign academic societies and related organizations are presenting data on new trends and strategic plans for diabetes education, and making various efforts, such as campaigns to improve awareness and dissemination of educational materials [10].

Currently, diabetes education in Korea is being conducted through an education team consisting of doctors, nurses and clinical dietitians at hospitals. However, there is still a lack of systems and infrastructure, many patients do not use health care systems, and the patient's cognitive rate or control rate is still low. In addition, there is a lack of national research on diabetes education. The purpose of this study was to compare the conduct rate of education and needs according to the control status of diabetes patients using data from the Korea National Health and Nutrition Examination Survey and to analyze whether diabetes education affects blood sugar control.

MATERIALS AND METHODS

Subjects

This study used data from the 2008–2013 National Health and Nutrition Survey. Among the 53,829 subjects surveyed for a total of 6 years, those under 20 years of age (n = 13,046) and those without diabetes (n = 37,690) were excluded. 3,093 diabetes patients were first extracted. Subsequently, 1,904 subjects were extracted, excluding 1,189 subjects who included missing variables and inappropriate response data. The criteria for glucose control were classified into a well-controlled group (HbA1c < 6.5%, n = 585) and uncontrolled group (HbA1c ≥ 6.5%, n = 1,319).

Variables

All variables used in this study referred to the Korea National Health and Nutrition Survey Data guidelines. Demographic factors was investigated to sex (male, female), age (20–44 years, 45–64 years, and ≥ 65 years), economic level (low, middle-low, middle-high, and high), educational level (≤ middle school graduate, high school graduate and ≥ college graduate), occupation (white color, blue color and no occupation), national basic livelihood recipient (yes, no), marriage status I (single, married) and marriage status II (with spouse, without spouse and others). Lifestyle-related factors were confirmed quality of life (EQ5D index < 1, ≥ 1), stress level (too much, much, a little and almost never), alcohol drinking and smoking, exercise practice by intensity (hard, moderate and walking), usual sleeping time (< 7 hours, ≥ 7 hours), obese status (underweight, normal, overweight and obesity) and regularity of meals. Diabetes mellitus (DM)-related factors was analyzed to duration of diagnosis (≤ 1 year, 2 to 5 years, 6–10 years, 11–15 years, > 15 years), current treatment method of DM (insulin injection, oral medication, diet and/or exercise control and other methods), experience of nutritional education, education institution (clinics and hospitals, oriental medicine clinics, public health center, open lecture, workplace training, other places) and total numbers of educations.

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Statistics

For all data, a complex sample analysis method was analyzed, using stratification, clusters, and step weights. The DM and education-related factors of the subjects were summarized in terms of mean and standard deviation for continuous variables and frequency and percentage (%) for categorical variables. Significant difference between well-controlled group and uncontrolled groups were identified by independent 2-sample t-test and Wilcoxon's rank-sum test in continuous data and Fisher's exact test in categorical data. Multivariate logistic regression analysis was also carried out to identify the factors that affect controlling of DM. Then it was visualized as a monogram. All analyses were carried out using R (version 3.6.1, The R Foundation for Statistical Computing, Vienna, Austria) and the statistical significance was set at 0.05 based on the 2-sided test.

RESULTS

Demographic factors in subjects

In the well-controlled group, the distribution of old age and national basic living recipients were significantly higher than in the uncontrolled group (**Table 1**).

Table 1. Demographic factors according to control status of blood glucose

Variable	Well-controlled (n = 585)	Uncontrolled (n = 1,319)	Total (n = 1,904)	p value
Sex				0.243
Male	298 (50.9)	632 (47.9)	930 (48.8)	
Female	287 (49.1)	687 (52.1)	974 (51.2)	
Age (yr)				< 0.001
20–44	30 (5.1)	55 (4.2)	85 (4.4)	
45–64	213 (36.4)	620 (47.0)	833 (43.8)	
≥ 65	342 (58.5)	644 (48.8)	986 (51.8)	
Economic level				< 0.001
Low	267 (45.6)	447 (33.9)	714 (37.5)	
Middle-low	137 (23.4)	366 (27.7)	503 (26.4)	
Middle-high	88 (15.1)	273 (20.7)	361 (19.0)	
High	93 (15.9)	233 (17.7)	326 (17.1)	
Educational level				0.117
≤ Middle school graduate	405 (69.2)	867 (65.7)	1,272 (66.8)	
High school graduate	110 (18.8)	304 (23.0)	414 (21.8)	
≥ College graduate	70 (12.0)	148 (11.2)	218 (11.4)	
Occupation				0.031
White color	70 (12.0)	218 (16.5)	288 (15.2)	
Blue color	170 (29.0)	381 (28.9)	551 (28.9)	
No occupation	345 (59.0)	720 (54.6)	1,065 (55.9)	
National basic livelihood recipient				0.004
No	512 (87.5)	1,212 (91.9)	1,724 (90.5)	
Yes	73 (12.5)	107 (8.1)	180 (9.5)	
Marriage status I				1.000
Single	10 (1.7)	24 (1.8)	34 (1.8)	
Married	575 (98.3)	1,295 (98.2)	1,870 (98.2)	
Marriage status II				0.395
With spouse	435 (74.4)	1,015 (77.0)	1,450 (76.2)	
Without spouse	140 (23.9)	279 (21.1)	419 (22.0)	
Others (Single)	10 (1.7)	25 (1.9)	35 (1.8)	

Data were presented as frequency (percentage). The p value was calculated by χ^2 test.

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Table 2. Lifestyle-related factors according to control status of blood glucose

Variable	Well-controlled (n = 585)	Uncontrolled (n = 1,319)	Total (n = 1,904)	p value
EQ5D index				0.524
< 1	316 (54.0)	690 (52.3)	1,006 (52.8)	
≥ 1	269 (46.0)	629 (47.7)	898 (47.2)	
Stress level				0.564
Too much	29 (5.0)	68 (5.2)	97 (5.1)	
Much	116 (19.8)	243 (18.4)	359 (18.9)	
A little	301 (51.4)	656 (49.7)	957 (50.3)	
Almost never	139 (23.8)	352 (26.7)	491 (25.7)	
Alcohol drinking	408 (69.7)	1,021 (77.4)	1,429 (75.1)	< 0.001
Smoking	95 (16.2)	253 (19.2)	348 (18.3)	0.142
Hard exercise	83 (14.2)	159 (12.1)	242 (12.7)	0.224
Moderate exercise	111 (19.0)	127 (9.6)	238 (12.5)	< 0.001
Walking	255 (43.6)	560 (42.5)	815 (42.8)	0.681
Sleep time (hr)				0.375
< 7	269 (46.0)	576 (43.7)	845 (44.4)	
≥ 7	316 (54.0)	743 (56.3)	1,059 (55.6)	
Obesity				0.007
Underweight	11 (1.9)	25 (1.9)	36 (1.9)	
Normal	350 (59.8)	688 (52.2)	1,038 (54.5)	
Overweight and obesity	224 (38.3)	606 (45.9)	830 (43.6)	
Regularity of meal				
Breakfast	518 (88.5)	1,211 (91.8)	1,729 (90.8)	0.029
Lunch	542 (92.6)	1,240 (94.0)	1,782 (93.6)	0.309
Dinner	556 (95.0)	1,265 (95.9)	1,821 (95.6)	0.466

Data were presented as frequency (percentage). The p value was calculated by χ^2 test.

Comparison of lifestyle-related factors in subjects

Among the total subjects, 47.2% showed a good quality of life of 1 point or higher, and 76% of all subjects had little or no stress, and there was no difference between the 2 groups. The drinking rate was 77.4% in the uncontrolled group, significantly higher than in the 69.7% in the well-controlled group, and the regular exercise rate of the moderate exercise was 19.0% in the well-controlled group and 9.6% in the uncontrolled group, and there were significant differences between the 2 groups. In the degree of obesity, the well-controlled group was 59.8% in normal, 38.3% in overweight and obesity. The uncontrolled group was 52.2% in normal, and 45.9% in overweight and obesity (**Table 2**).

Comparison of DM-related factors in subjects

Diabetes diagnosis period was significantly shorter in the well-controlled group than in the uncontrolled group. The proportion of respondents who said they were treating for diabetes was 84.6% in the well-controlled group and 92.6% in the uncontrolled group. As a treatment method, the ratio of insulin injection and use of oral medication in the uncontrolled group was significantly high. In the subjects, the experience rate of nutritional education was 14.4% in the well-controlled group and 10.2% in the uncontrolled group. As for the institution of receiving education, there was a significant difference in 8.9% of hospitals in the well-controlled group, 7.2% in various open lectures, 5.1% in public health centers. The total number of educations showed significant difference in 0.28 times in the well-controlled group and 0.15 times in the uncontrolled group (**Table 3**).

Factors affecting glucose control

Table 4 shows the analysis results of factors affecting glucose control through various variables of the subjects. As a result of performing multiple logistic regression by recalibrating the significant factors through a univariate analysis, the significant factors were

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Table 3. DM-related factors according to control status of blood glucose

Variable	Well-controlled (n = 585)	Uncontrolled (n = 1,319)	Total (n = 1,904)	p value
Duration of diagnosis of DM (year)				< 0.001
≤ 1	126 (21.5)	158 (12.0)	284 (14.9)	
2–5	180 (30.8)	280 (21.2)	460 (24.2)	
6–10	143 (24.4)	312 (23.7)	455 (23.9)	
11–15	66 (11.3)	249 (18.9)	315 (16.5)	
> 15	70 (12.0)	320 (24.2)	390 (20.5)	
Treatment method of DM	495 (84.6)	1,222 (92.6)	1,717 (90.2)	< 0.001
Insulin injection	16 (2.7)	150 (11.4)	166 (8.7)	< 0.001
Oral medication	470 (80.3)	1,157 (87.7)	1,627 (85.5)	< 0.001
Diet and/or exercise control	128 (21.9)	328 (24.9)	456 (23.9)	0.177
Other method (remedy and etc on)	2 (0.3)	3 (0.2)	5 (0.3)	1.000
Nutritional education	84 (14.4)	134 (10.2)	218 (11.4)	0.010
Education institution	118 (20.2)	185 (14.0)	303 (15.9)	0.001
Clinics and hospitals	52 (8.9)	69 (5.2)	121 (6.4)	0.004
Oriental medicine clinics	12 (2.1)	34 (2.7)	46 (2.4)	0.597
Public health center	30 (5.1)	15 (1.1)	45 (2.4)	< 0.001
Open lecture	42 (7.3)	66 (5.0)	108 (5.6)	0.074
Workplace training	16 (2.7)	0 (0.0)	16 (0.8)	< 0.001
Other places	11 (1.9)	15 (1.1)	26 (1.4)	0.282
Total No. of educations	0.28 ± 0.74	0.15 ± 0.41	0.19 ± 0.54	< 0.001

Data were presented as mean±standard deviation for continuous variables and frequency (percentage) for categorical variables. The p value was calculated by independent t-test or Mann-Whitney U test for continuous variable and χ^2 test or Fisher's exact test for categorical variables.
DM, diabetes mellitus.

Table 4. Logistic regression analysis for control status of blood glucose

Variable	Univariable		Multivariable	
	OR (95% CI)	p value	OR (95% CI)	p value
Demographic factor				
Age 45–65 (vs. 19–44)	1.59 (0.99–2.54)	0.055	1.20 (0.73–1.97)	0.468
Age ≥ 65 (vs. 19–44)	1.03 (0.65–1.63)	0.910	0.70 (0.43–1.14)	0.151
Middle-low income (vs. low)	1.60 (1.25–2.04)	< 0.001	-	-
Middle-high income (vs. low)	1.85 (1.39–2.46)	< 0.001	-	-
High income (vs. low)	1.50 (1.13–1.99)	0.005	-	-
White color (vs. No occupation)	1.49 (1.11–2.01)	0.009	-	-
Blue color (vs. No occupation)	1.07 (0.86–1.34)	0.529	-	-
National basic livelihood recipient	0.62 (0.45–0.85)	0.003	-	-
Lifestyle-related factor				
Alcohol drinking	1.49 (1.19–1.85)	< 0.001	1.34 (1.06–1.70)	0.014
Moderate exercise	0.45 (0.35–0.60)	< 0.001	0.45 (0.34–0.60)	< 0.001
Overweight and obesity	1.37 (1.12–1.67)	0.002	1.44 (1.17–1.78)	< 0.001
Having breakfast	1.45 (1.05–2.00)	0.024	-	-
DM-related factor				
Duration of diagnosis of DM (yr)	1.06 (1.04–1.08)	< 0.001	1.07 (1.05–1.08)	< 0.001
Treatment method of DM	2.29 (1.69–3.11)	< 0.001	2.00 (1.45–2.77)	< 0.001
Nutritional education	0.67 (0.50–0.90)	0.008	0.62 (0.46–0.85)	0.003
Education institution	0.65 (0.50–0.83)	< 0.001	0.71 (0.54–0.93)	0.013

OR, odds ratio; CI, confidence interval; DM, diabetes mellitus.

analyzed drinking (odds ratio [OR], 1.34; 95% confidence interval [CI], 1.06–1.70), moderate exercise (OR, 0.45; 95% CI, 0.34–0.60), overweight and obesity (OR, 1.44; 95% CI, 1.17–1.78), duration of diagnosis (OR, 1.07; 95% CI, 1.05–1.08), treatment method (OR, 2.0; 95% CI, 1.45–2.77), nutritional education (OR, 0.62; 95% CI, 0.46–0.85), and education institution (OR, 0.71; 95% CI, 0.54–0.93). The results of the monogram representation of the regression analysis results are shown in **Figure 1**. If the sum of points for each variable is higher than the cutoff value of 0.714, it is confirmed that glucose is not controlled (**Table 3** and **Figure 1**).

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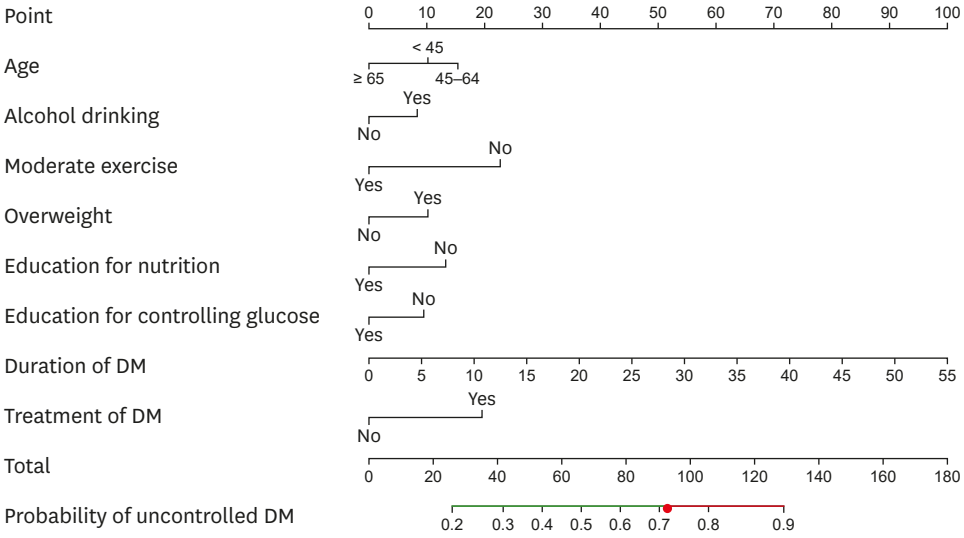

Figure 1. Nomogram for predicting the uncontrolled glucose in patients with DM.
Instruction for using the nomogram is as follows. First, draw a straight upward line to 'Point' axis and determine the points contributed by age. In this case, the subjects aged 45 to 64 contributes to 14 points, while being aged below 45 and over 65 contributes to 10 and 0 points, respectively. Second, repeat the same process for alcohol drinking, moderate exercise, overweight, education for nutrition or controlling glucose, duration of DM, and treatment of DM. Third, add up all the points from the 8 domains to get total points. Last, draw a straight downward line from the 'Total' axis to the 'Probability of uncontrolled DM' axis and get the estimated probability. The probability of greater than 0.714 was determined as the patient un-controlling glucose. The cutoff value of 0.714 was computed by Youden's index.
DM, diabetes mellitus.

DISCUSSION

Diabetes education has been important both treatment and prevention, and patients themselves must have sufficient knowledge of diabetes for success of treatment [11]. In the previous study, it was found that patients with diabetes education had higher knowledge and better glucose control than patients without education [12]. In this study, we tried to confirm again the importance of diabetes education through national big data analysis based on several reports that the control rate is very low compared to the awareness rate of diabetic patients in Korea and the education performance rate is still low. As a result of analysis, the uncontrolled group had a relatively young age group and a significantly higher proportion of the white-color occupational group. Diabetes patients in Korean, the age of diagnosis is getting lower, and this is related to the increase in insulin resistance and the increase in obesity due to the westernization of diet and decreased activity [13]. In addition, the uncontrolled group showed a higher rate of drinking, a lower rate of moderate exercise, and a higher rate of obesity. These results suggest that more dietary control and exercise practice need to be aggressively involved, considering the results of a prior study in which exercise and dietary control have a significant effect on blood sugar in managing diabetes [14,15].

In the result of analysis of factors related to diabetes, the uncontrolled group had a relatively long diagnosis duration and a high rate of drug treatment, but the rate of nutrition education and the total number of educations were found to be significantly lower. Having analyzed the factors affecting glucose control, it was found that drinking, overweight and obesity, diabetes diagnosis duration and treatment status had a negative effect on glucose control, and nutrition education and education place had a positive effect. Diabetes is important for dietary management, but it is one of the most difficult practices for many patients, and medications ordered by doctors are continued, but nutrition education is often avoided [16]. However, there have been many studies that showed that patients with diabetes nutrition

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education have not only altered nutrient intake but also increased nutritional knowledge and showed desirable eating behaviors [17,18]. Furthermore, the need for more systematic counseling and dietary adjustment has been steadily proposed to manage for a long time and prevent complications, and educators in various fields should cooperate to induce patient changes [19]. Diabetes is known to be more effective in improving glucose levels as the number of education interventions increases, and regular and frequent education programs are known to help self-management [20]. There was also a study that confirmed that the intervention group had increased self-care and self-efficacy compared to the control group when education for 12 weeks was provided to patients with type 2 diabetes once a week for a total of 12 weeks [21]. This study is a retrospective study, so it is not possible to confirm the clinical outcome depending on the content, method, and frequency of education, but education must be performed on patients diagnosed with diabetes as the educational experience and frequency of education in the uncontrolled group is significantly lower to be ultimately recognized as a treatment method. Among the subjects, the proportion of those educated through public health centers and clinics is relatively low. Of course, it is necessary to access the knowledge of diabetes through diverse channels, yet it is necessary to expand the base so that education can be conducted in institution where mediation can be more professional and tailored to the health condition, characteristics, and needs of the individual.

Although our research is representative sample data of the people as a national health and nutrition survey data, it has limitations that an error in sampling rate may have occurred due to cross-sectional study at a certain time of investigation, and that it may contain errors such as response bias. The relevance of various factors, such as glucose control and educational performance, can be found, but it is difficult to clearly identify causal relationship. Moreover, due to the old data, it does not reflect the recent trends. This is because many variables related to diabetes were excluded after the fifth data of the Korea National Health and Nutrition Examination Survey. However, it can still be meaningful that many factors such as socio-economic indicators and lifestyles were combined and that the analysis of a large number of people was conducted.

CONCLUSION

Diabetes patients are steadily increasing, so several national management plans are being pursued, but policies including the cost of educations have not been continuously improved. Based on this study, it is necessary to standardize education management and improve the level of educators and programs for diabetes. We think that the education performance rate of diabetes should be increased by providing various educational institutions with convenient access. Finally, various national survey should be resumed, and multidisciplinary studies on the educational effects should be attempted.

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