

Smoking, Hemoglobin A1c and Complications in People with Type 2 Diabetes Mellitus



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Abstract

OBJECTIVES: To study the proportion of smokers in people with type 2 diabetes and to compare the glycemic control and diabetic complications of smokers, former smokers and non-smokers.

MATERIAL AND METHODS: The study was a cross-sectional descriptive study of patients with type 2 diabetes aged 15 years old and over who received services at the Diabetes Clinic, Outpatient Department of Internal Medicine, Ramathibodi Hospital from April 2014 to January 2015.

RESULTS: Of 313 participants, 2.6% of type 2 diabetes subjects were smokers, and 16.3% of participants were former smokers. All smokers were males. The BMIs of the non-smokers and the former smokers were higher than that of the smokers (26.8, 27.1 and 25.4 kg/m², respectively). Moreover, former smokers had a higher prevalence of being overweight (BMI > 23 kg/m²) more than the smokers and non-smokers (74.5%, 62.5% and 57.1%, respectively). The average levels of triglycerides and cholesterol in the smokers (mean was 177.0 and 192.3 mg/dL, respectively) were higher than those of non-smokers (mean was 147.3 and 181.0, respectively) and former smokers (mean was 142.6 and 165.1, respectively). Moreover, it was shown that the average of HbA1c in all groups were not different. However, the smokers were more likely to have uncontrolled diabetes (HbA1c ≥ 7%) more than the non-smokers and the former smokers (75.0% of the smokers, 55.9% of the non-smokers and 51.0% the former smokers). Regarding diabetes complications, including retinopathy neuropathy and nephropathy, it was found that the smokers and the former smokers had a higher percentage of complications than the nonsmokers.

CONCLUSION: People with diabetes who smoked were more likely to have poor glycemic control and tended to have more complications than non-smokers. Therefore, in diabetic care, smoking cessation is important for glycemic control and limiting the development of diabetic complications. It is suggested that integrated care for the patients with diabetes should be supported. That is, clear guidelines regarding the diet control, balanced exercises and the assessment of risk behaviors, especially smoking, are recommended.

Keywords: smoking, type 2 diabetes, diabetic complications

Diabetes is a chronic disease that has been increasing both at the global and the national level. According to data of the World Health Organization (WHO) in 2012, it was found that 1 in 10 of the world's adult population has diabetes.¹ In Thailand, the prevalence of diabetic patients aged 35 years or above was 9.6%, or about 2.4 million people,² and the prevalence in the population aged 15 years and above had increased from 6.7% in the year 2004 to 6.9% in the year 2009.³⁻⁴ Moreover, it was revealed that people with diabetes are unable to control their blood sugar level,⁴ and this causes incidences of complications leading to the loss of function in various organs such as the eyes, kidneys, heart, nervous system and blood vessels. The inability to control blood sugar level is often caused by behavioral problems including eating an unhealthy diet, lack of exercise, stress and smoking.

Smoking is a major behavioral common risk factor of many chronic diseases. People who smoke have a higher risk of diabetes than those who do not smoke since smoking has resulted in the

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Received: July, 8, 2015.

Revision received: July, 10, 2015.

Accepted after revision: July, 16, 2015.

Bangkok Med J 2015;10:15.

E-journal: <http://www.bangkokmedjournal.com>

increase of insulin resistance and the risk of impaired glucose tolerance.⁵⁻⁹ Therefore smokers run a higher risk of developing diabetes than non-smokers. Furthermore, smoking is a major common risk factor that causes complications resulting from having diabetes (both microvascular and macrovascular).⁷ According to the study, it was found that smoking is associated with an increase in Hemoglobin A1c (HbA1c),^{7,10} so people with diabetes cannot control their blood sugar level. It was also found that smokers are at risk of coronary heart disease and stroke at a rate of about 2-3 times higher than non-smokers.¹¹⁻¹²

Several studies have shown that quitting smoking can reduce the risk of diabetes.¹³⁻¹⁵ Therefore quitting smoking is a major guideline for both people with and without diabetes. Studies that explore the proportion of smokers in Thai type 2 diabetes subjects are scarce. The aims of this study were to study the proportion of smokers in people with type 2 diabetes and to compare glycemic control and diabetes complications between smokers, non-smokers and former smokers to assist health care teams to apply the study's results as a basis for improving the care given to diabetic patients. The study is also expected to help provide guidelines for the development of a comprehensive and effective care model for people with diabetes, especially those who are smokers, to control diabetes and to prevent complications that might occur.

Material and Methods

The study was a cross-sectional descriptive study. The study participants were 313 patients with type 2 diabetes aged 15 years old and above who received services at the Diabetes Clinic, Out-patient section of the Internal Medicine Department, Ramathibodi Hospital from April 2014 to January 2015.

The research instruments for data collection included the data record form collecting the data from the medical records and the questionnaire on smoking, which consisted of 3 parts as follows:

- **Part 1:** General information including age, gender, educational level, marital status, and duration of having diabetes.
- **Part 2:** The information record sheet about metabolic control, diabetic control and complication of diabetes, including weight, height, triglyceride level, cholesterol level, blood sugar level and the incidences of complications which can be divided as:
 - 1) retinopathy: the data obtained from the medical records by the ophthalmologist.
 - 2) nephropathy: the data obtained from the medical records showing that the presence of albuminuria evaluated by the doctors.

- 3) neuropathy: the data obtained from the medical records showing the presence of the decline of foot sensation or pulses or having serious foot problems, such as ulcers, infections, and deformities evaluated by the specialists or the doctors.

- **Part 3:** The questionnaire on smoking. Smoking status was divided into 3 groups: the smokers which refer to those who regularly smoke; the former smokers which refer to those who had smoked in the past and stopped smoking for more than six months; and the non-smokers which refer to those who had never smoked.

The data collection was conducted after receiving approval from the Human Research Ethics Committee, Faculty of Medicine, Ramathibodi Hospital, Mahidol University. The data were collected by using the questionnaire and the data record form from the medical records of the participants. The information of the patients participating in this research was treated with confidentiality. The participants' names were not disclosed.

Statistical analysis

The statistical analysis was performed using Predictive Analytics SoftWare (PASW) 18 program (Mahidol license). The number, percentage, mean and standard deviation of demographic data, duration of DM, glycemic control and complications in each smoking status were calculated. A Chi Square test was used to analyze the categorical data and Analysis of Variance (ANOVA) was utilized to analyze the continuous data to compare various factors between the smokers, the former smokers and the non-smokers.

Results

Of 313 participating patients, the majority of participants were female (62.6%). The mean age was 61.1 years old and 60.4% of the participants were over 60 years old. Of the participants, 29.4% of had an educational level lower or equal to grade 6. The average duration of having diabetes was 11.0 years. The proportion of smokers was 2.6% and former smokers were 16.3%. There was no statistically significant difference in demographic data among all groups of smoking, except gender. That is, all of the smokers and 92% of the former smokers were male whereas most of non-smokers were female (75.6%). The mean age of all groups was close to each other. The group of smokers tended to represent a higher percentage of all participants who had graduated from school with lower or equal to grade 6 when compared to those who used to smoke and the non-smokers. The duration of having diabetes of participants who were former smokers and the non-smokers was longer than that of the smokers as shown in Table 1.

Table 1 : Demographic characteristics of study participants categorized by smoking status (n=313).

Characteristic	Non-smoker (n = 254)	Smoker (n = 8)	Former smoker (n = 51)	Total (n = 313)	p^*
Males	62 (24.4)	8 (100.0)	47 (92.2)	117 (37.4)	< 0.001
Average age (years)	60.6 (11.9)	60 (5.7)	63.6 (8.8)	61.1 (11.3)	0.568
Age \geq 60 years	149 (58.7)	5 (62.5)	35 (68.6)	189 (60.4)	0.411
Educational level \leq grade 6	71 (29.6)	5 (62.5)	11 (22.9)	87 (29.4)	0.074
The duration of having DM (years)	11.0 (8.6)	6.6 (6.2)	11.8 (7.3)	11.0 (8.4)	0.856

The result of the analysis was n (%) or mean (SD)

* p from the analysis of chi-square tests (for categorical data) or analysis of variance tests (for continuous data)

We further compared metabolic control, glycemic control and diabetic complications among groups. There were no differences in BMI, percentage of overweight participants (BMI > 23 kg/m²), the triglyceride level and the cholesterol level.

However, both the former smokers and the non-smokers had a higher BMI than the smokers (27.1, 26.8 and 25.4 kg/m², respectively). The smokers and former smokers had a higher percentage of being overweight (BMI > 23 kg/m²) than those of the non-smokers (74.5%, 62.5% and 57.1%, respectively). The average of triglycerides and cholesterol in the smokers (mean was 177.0 and 192.3, respectively) were higher than in the non-smokers (mean was 147.3 and 181.0, respectively) and former smokers (mean was 142.6 and 165.1, respectively).

When considering the glycemic control defined by HbA1c level, HbA1c in all groups were similar. But the smokers had a higher percentage of uncontrolled HbA1c (HbA1c \geq 7%) than the non-smokers and the former smokers (75.0% of the smokers, 55.9% of the non-smokers and 51.0% of the former smokers).

Regarding the prevalence of diabetes complications, it was revealed that both the smokers and the former smokers had nephropathy, retinopathy and neuropathy at higher rates than those of the non-smokers. Comparing all diabetic complications in smokers, the prevalence of retinopathy was the highest (Table 2).

Table 2 : Metabolic control, Glycemic control and diabetic complications of the participants categorized by smoking status.

Characteristic	Non smoker (n = 254)	Smoker (n = 8)	Former smoker (n = 51)	Total (n = 313)	p^*
Metabolic control					
BMI (kg/m ²)	26.8 (4.7)	25.4 (3.6)	27.1 (6.3)	26.8 (5.0)	0.663
BMI > 23 (kg/m ²)	145 (57.1)	5 (62.5)	38 (74.5)	188 (60.1)	0.167
Triglyceride (mg/dl)	147.3 (85.3)	177.0 (60.8)	142.6 (92.3)	147.3 (85.1)	0.873
Total cholesterol (mg/dl)	181.0 (44.5)	192.3 (22.6)	165.1 (48.5)	178.8 (45.0)	0.117
Glycemic control					
HbA1c (%)	8.0 (1.9)	7.9 (1.8)	7.8 (2.0)	8.0 (1.9)	0.794
HbA1c \geq 7%	142 (55.9)	6 (75.0)	26 (51.0)	174 (55.6)	0.256
Diabetic complications					
Retinopathy	56 (22.4)	3 (37.5)	15 (29.4)	74 (23.6)	0.460
Neuropathy	47 (18.5)	2 (25.0)	13 (25.4)	62 (19.8)	0.529
Nephropathy	29 (11.4)	1 (12.5)	11 (21.6)	41 (13.1)	0.164

The result of the analysis was n (%) or mean (SD)

* p from the analysis of chi-square tests (for categorical data) or analysis of variance tests (for continuous data)

Table 3 : Glycemic control and diabetic complications of the participants categorized by smoking status.

Factors	Non smoker (n = 254)	Smoker (n = 8)	Former smoker (n = 51)	<i>p</i> *
Age				
Age < 60 years	n = 105	n = 3	n = 16	
Glycemic control				
HbA1c (%)	8.4 (2.0)	9.2 (2.2)	8.6 (2.2)	0.306
HbA1c ≥ 7%	74 (70.5)	3 (100.0)	12 (75.0)	0.694
Diabetic complications				
Retinopathy	19 (18.1)	1 (33.3)	5 (31.3)	0.522
Neuropathy	15 (14.3)	0	6 (37.5)	0.075
Nephropathy	7 (6.7)	0	3 (18.8)	0.213
Age ≥ 60 years	n = 149	n = 5	n = 35	
Glycemic control				
HbA1c (%)	7.7 (1.7)	7.1(1.1)	7.5 (1.8)	0.523
HbA1c ≥ 7%	68 (45.6)	3 (100.0)	14 (40.0)	0.374
Diabetic complications				
Retinopathy	37 (24.8)	2 (66.7)	10 (28.6)	0.745
Neuropathy	32 (30.5)	2 (66.7)	7 (20.0)	0.636
Nephropathy	22 (14.8)	1 (33.3)	8 (22.9)	0.550
Duration of DM				
Having DM < 5 years	n = 66	n = 3	n = 7	
Glycemic control				
HbA1c (%)	8.1 (1.9)	7.3 (1.3)	7.5 (1.6)	0.650
HbA1c ≥ 7%	37 (56.1)	2 (66.7)	3 (42.8)	0.659
Diabetic complications				
Retinopathy	5 (7.6)	0	2 (28.6)	0.217
Neuropathy	5 (7.6)	0	2 (28.6)	0.187
Nephropathy	3 (4.5)	0	0	0.504
Having DM ≥ 5 years	n = 188	n = 5	n = 44	
Glycemic control				
HbA1c (%)	8.0 (1.8)	8.4 (2.1)	7.9 (2.1)	0.843
HbA1c ≥ 7%	105 (55.9)	4 (80.0)	23 (52.3)	0.337
Diabetic complications				
Retinopathy	51 (27.1)	3 (60.0)	13 (29.5)	0.298
Neuropathy	42 (22.3)	2 (40.0)	11 (25.0)	0.672
Nephropathy	26 (13.8)	1 (20.0)	11 (25.0)	0.211

The result of the analysis was n (%) or mean (SD)

**p* from the analysis of chi-square tests (for categorical data) or analysis of variance tests (for continuous data)

In addition, we stratified subjects according to age (< 60 or ≥ 60 years) and duration of diabetes (< 5 or ≥ 5 years) and further compared glycemic control and prevalence of diabetic complications among groups of smoking status. When considering subjects stratified by group, there were no differences in metabolic control, diabetic control and diabetic complications in all groups. However the average of HbA1c of the smoker group who were

younger than 60 years was higher than those of the former smoker and the non-smoker groups. In addition the smokers who were younger than 60 years and older than 60 years had a higher proportion of HbA1c ≥ 7% (100% both in both groups) than the former smokers (75.0% and 40.0%) and the non-smokers (70.5% and 45.6%) as shown in Table 3. For the prevalence of diabetes complications, the groups of smokers and the former smokers of both

age groups had a higher rate of complications including nephropathy retinopathy and neuropathy than those of the non-smokers. The smokers had the highest proportion of retinopathy while the former smokers had the highest proportion of both neuropathy and nephropathy (Table 3).

When considering the duration of having diabetes, it was found that the group of the smokers who had had diabetes for five years and longer had the highest average of HbA1c (the average of HbA1c was 8.4%). The proportion of uncontrolled HbA1c (HbA1c \geq 7%) of the smokers of both groups (< 5 or \geq 5 years) was higher than that of the former smokers the non-smokers. Regarding the prevalence of complications, it was revealed that in both groups of smokers who had diabetes for five years and longer had complications including retinopathy neuropathy and nephropathy at a higher rate than those of the former smokers and the non-smokers (Table 3).

Discussion

The results of this study showed that 2.6 % of people with diabetes were smokers and 16.3% of them were former smokers. There were differences in the gender factor and it was found that the smokers and the former smokers were mostly males while the non-smokers were mostly females. The ratio was significantly different. The results were different from the study of Nilson et al.¹⁰ in which it was found that the ratio of female to male patients with diabetes who smoked was almost the same. Nonetheless, when we considered young individuals, the prevalence of smokers was higher in females. This may be due to social and cultural norms of Thais that have traditionally prevented women from smoking.

According to the study on BMI and the overweight status, it was shown that the average BMI of the smokers was lower than that of the former smokers and the non-smokers. The average BMI and the percentage of being overweight were the highest for the former smokers. This was consistent with the study of Nilson et al.¹⁰ and Chiolero et al.¹⁶ which found that patients with diabetes who were smokers had a lower BMI than those who did not smoke. In addition, it was also consistent with the study of Wannamethee et al.¹³ studying the effects of smoking among patients with diabetes and it was found that after quitting smoking, the BMI of patients with diabetes increased. This can be explained by the fact that the intake of Nicotine has resulted in an increase of the use of energy expenditure and a reduction of appetite.¹⁷

Although there was no statistically significant difference in HbA1c among the groups of the smokers, the former smokers and the non-smokers, it was found

that the smokers and the former smokers had a higher percentage of uncontrolled HbA1c (HbA1c \geq 7%) than that of the non-smokers. For those who had had diabetes for more than five years, it was revealed that the average of HbA1c of the smokers was higher than that of the non-smokers and the former smokers, including the smokers who had had diabetes less than five years. This was in accordance with the study of Nilson et al.¹⁰ in which it was found that the patients with both type 1 and type 2 diabetes who were smokers had a level of HbA1c higher than non-smokers. In addition, the study of Clair and Bitton¹⁷ studying the effects of smoking on the level of HbA1c in the population who were not diabetic revealed that the level of HbA1c of the smokers was higher than in those who were non-smokers. Studies have shown that nicotine not only has a direct toxic effect on the pancreatic β -cells but is also associated with the development of insulin resistance by inducing a reduction of insulin resistance and negatively affecting insulin action.¹⁸ In terms of complications, the results of this study show that the percentage of the prevalence of diabetes complications in the smokers was higher than that of the non-smokers, and it clearly increased in people with diabetes having diabetes for a longer period (greater than or equal to 5 years). This is because smoking affects microvascular complications. There is clear evidence, especially in terms of nephropathy.⁷

Conclusion

Although there are differences in glycemic control and diabetic complications among smoking groups, people with diabetes who smoked in the past were more likely to have poor glycemic control and tended to have more complications than those who did not smoke. Our study suggests that the assessment of smoking behaviors should be added to the guidelines for diabetes care. However, smoking prevention and smoking cessation may not be emphasized enough in diabetes clinics. Therefore, encouraging all diabetic patients to stop smoking and transferring them to smoking cessation clinics in order to give them an education on the importance of the need to stop smoking and engaging in smoking cessation programs is important for glycemic control and limiting the development of diabetic complications. In addition, further studies that are able to explore the effects of smoking should be conducted in order to further understanding of the differential impact of smoking on glycemic control and diabetic complications.

Acknowledgements

This study was funded by Faculty of Medicine Ramathibodi Hospital, Mahidol University.

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