Factors Associated with the Effectiveness of Diabetes Care at Primary Care Settings

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Objective: *To assess the effectiveness of diabetes care and the factors associated with the effectiveness at primary care settings.*
Material and Method: *Data were obtained from reviewing of 1,795 medical patient files of patients with type 2- DM treated at forty-eight primary care settings. Information recorded included characteristics, body mass index, co-morbidity, fasting blood glucose (FBG) and HbA_{1c} levels and health personnel mix types (physicians, pharmacists, nurses, health technical officers and community health workers). HbA_{1c} level of diabetes in 542 of 1,795 medical patient files were analyzed. Glycemic controllability of diabetes patients was defined using FBG and HbA_{1c} levels as the effectiveness indicators of diabetes care.*
Results: *Of 1,795 patients, 40.8% were able to control their FBG levels and 22.7% of the 542 patients who have HbA_{1c} data could control their HbA_{1c} levels. Multivariate analysis confirmed that age and health personnel mix types are significant factors for glycemic controllability as measured by FBG level ($p < 0.01$). By measuring HbA_{1c} level, age was also significant factor in diabetes care effectiveness ($p = 0.012$).*
Conclusion: *Age was a significant factor in controlling both FBG and HbA_{1c} levels in type 2 diabetes whereas health personnel, physicians and pharmacists, are significant factors in increasing effectiveness of diabetes care. The policy makers should consider distributing these health personnel to primary care settings and this would be a challenge for the policy makers to develop such a strategy and to implement this policy.*

Keywords: *Factors associated, Effectiveness, Diabetes care, Primary care setting*

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Diabetes mellitus (DM) is a major chronic disease and is one of the major public health and clinical problems in many countries since its prevalence is still increasing[1,2]. It was estimated that in 2010, the worldwide prevalence of diabetes among adults was 6.4%, which affected 285 million adults and the estimated figure will increase to 7.7% in 2,030 or 439 million adults may suffer from the disease[2]. An increasing trend has been witnessed in Thailand from 33.3 per 100,000 population in 1985 to 91.0 in 1994 and to 586.8 in 2006[3].

Like in many countries, Thailand has focused and shifted the diabetes care from secondary care to primary care level to provide accessible and equitable quality health services[4-6]. In Thailand, the workforce criteria for health personnel at primary care setting have been systematically set up for quite some time, however, in the real situation personnel mix, a mix of different of types of staff within a multidisciplinary team[7], of diabetes care at primary care settings are still not yet fully developed. Physicians and pharmacists are not available at every primary care setting since they must oversee other primary care settings as well as the community hospitals at the same time[7]. As of the situation like this, one may raise a question whether there are any differences of the effectiveness of diabetic care in a primary care setting between these two kinds of personnel mixes, one with physicians and pharmacists available and another one without these health personnel.

Studies in many countries reported the effectiveness of diabetic care in both primary and tertiary care settings[8,9]. In the scarcity of the diabetic

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care effectiveness studies in Thailand, it is surprising that most of them were undertaken at tertiary care settings[10,11]. Therefore, in the context of recent national policy that shifted the diabetes care from tertiary and secondary to primary care level in Thailand, it is worthwhile to conduct a study aiming at exploring the effectiveness of diabetic care in the primary care settings. Both types of personnel mix in the primary care settings, one with physicians and pharmacists available and another without both physicians and pharmacists, have been critically studied. Associated factors that might affect effectiveness in the diabetic care units have also been analyzed.

The present study aimed to examine the effectiveness of diabetes care and factors associated with the effectiveness at primary care settings in Thailand. It is expected that the results of the present study could more or less help to improve the quality of diabetes primary settings in Thailand.

Material and Method

The present study employed a retrospective study design and was approved by the Institutional Review Board of Mahidol University. Data were collected between January 2009 and June 2009 from medical patient files at 48 primary care settings in two provinces, namely Samut Prakan and Chachoengsao. Of the 48 primary care settings studied, a health personnel mix or a mix of health personnel (*i.e.* physicians, pharmacists, nurses, technical officers and community health workers) were responsible for taking care of the DM patients. Thirty out of the 48 primary care settings had physicians and pharmacists who provided the diabetes care, whereas the rest of them, 18 settings, no such personnel were available. Practitioner nurses and community health workers were full-time health personnel who provide diabetes care at every primary care setting. In a primary care setting where physicians and pharmacists were not available, the nurses would have assessed and treated the patients. In addition, if the patients were able to maintain FBG level, the primary care nurses would have given the same previous medications that used to be ordered by physicians but if they were not, they were transferred to visit physicians at the community hospitals.

The data were collected by 48 trained enumerators who were nurses or health technical officers working at the primary care settings. All eligible patients' files with diabetes mellitus (DM) were selected to the present study. Inclusion criteria for selection of medical patient files were a) patients who had type 2-DM and been treated at the selected primary care settings for more than six months and had not been diagnosed with hypertension and cholesterol problems, b) the files that had sufficient information on the patients' age, gender, weight, height, fasting blood glucose (FBG) level and co-morbidity. There were three steps of collecting data (Fig. 1). First, enumerators chose DM patients' files from the chronic disease registrations out of 48 primary care settings, which were 6,397 files. The second step, 1,795 files that had information of age, gender, weight, height and FBG levels were selected and were grouped and labeled as FBG-measured group. Step 3, from FBG-measured group, 542 files with information on HbA_{1c} were grouped and labeled as HbA_{1c}-measured group.

Glycemic controllability has been accepted as a factor to quantify the effectiveness of diabetes care[12,13]. While measurement of HbA_{1c} level has been used as the ability of the glycemic control internationally, both FBG and HbA_{1c} have been used to assess the glycemic control in most health care units in Thailand. In the present study, glycemic controllability of diabetes patients was defined using FBG and HbA_{1c} levels as the effectiveness indicators of diabetes care. According to the standard criteria of the American Diabetes Association (ADA) and the Diabetes Association of Thailand, the effectiveness

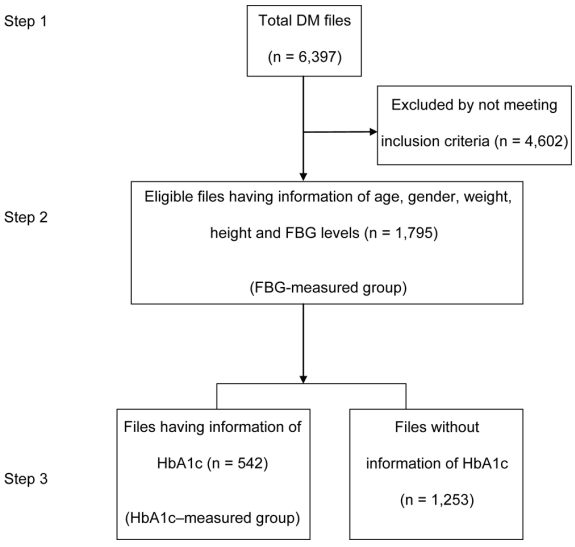

Fig. 1 Flow chart of selecting and grouping process of medical patient files

of glycemic controllability were defined as fasting blood glucose level of between 70 and 130 mg/dl and HbA_{1c} being less than 7.0%[12,13]. Last FBG levels within three months and last HbA_{1c} levels within one year were collected and analyzed. The patients who had FBG and HbA_{1c} levels within these values were defined as glycemic controllable patients. Uncontrollable patients mean these two values were beyond the cut off points. Standard body mass index (BMI) in the present study was defined within the range of 18.5-22.9 kg/m^2 and BMI was calculated from weight in kilograms divided by the square of height (meters)[13].

SPSS PASW version 18 was used to analyze the data. The Chi-squared test for categorical variables and Unpaired t-test for continuous variables were statistical tests employed in the present study. Logistic Regression and multivariate analysis (odds ratio with 95% CI) were performed to confirm the results. A p-value of less than 0.05 was considered statistically significant.

Results

The characteristics and glycemic controllability among FBG-measured group are shown in Table 1. The diabetes patients were between 22 and 90 years old with a mean (SD) age of 59.95 (11.19) years. There were about twice as many women (69.9%) as men (30.1%) having diabetes care at the primary care settings. The majority of patients had BMI values lower or higher than the standard level (74.2%). Health personnel mix type with physicians and pharmacists available were 72.3% in FBG-measured group. Average blood glucose levels were 147.84 mg/dl. Regarding glycemic controllability, controllable patients as measured by FBG level were 40.8%.

Age of diabetes patients and health personnel mix type providing the patient cares was significantly associated with glycemic controllability measured by FBS level as shown in Table 2 ($p < 0.001$ and 0.01 respectively). Gender, BMI, and co-morbidity were not statistically significant factors associated with the diabetic care effectiveness. Two factors namely age (odds ratio: OR = 1.021; 95% confidence interval 1.012-1.030) and clinical personnel mix type (OR = 0.593; 95% confidence interval 0.476-0.740) were statistically significantly predictive for FBG control. Multivariate analysis also confirmed the results.

Table 3 shows characteristics and glycemic controllability in HbA_{1c}-measured group. The results were similar in FBG–measured group as shown in Table 1. Both groups had an age range between 51 and 70 years (average 59.95 in FBG-measured group and 60.04 in HbA_{1c}-measured group) and most were female (female to male = 70:30 and 72:28). The majority of patients had BMI values lower or higher than the standard level (74.2% in FBG-measured group and 77.5% in HbA_{1c}-measured group). Health personnel

Table 1. Characteristics of 1,795 type 2 diabetes patients whose glycemic controllability was assessed by fasting blood glucose level (FBG)

	FBG-measured group*
Age, years	
Mean (SD)	59.95 (11.19)
Min, Max	22, 90
Median (IQR)	60.00 (16.00)
Age group, years n (%)	
< 40	76 (4.2%)
41-50	296 (16.5%)
51-60	548 (30.5%)
61-70	548 (30.5%)
> 70	327 (18.2%)
Gender, n (%)	
Male	541 (30.1%)
Female	1,254 (69.9%)
BMI (kg/m^2)	
Mean (SD)	22.50 (4.84)
Min, Max	10.25, 82.93
Median (IQR)	24.97 (5.61)
BMI group, n (%)	
Within standard range**	463 (25.8%)
Lower/higher than standard range**	1,332 (74.2%)
Co-morbidity, n (%)	
With co-morbidity	278 (15.5%)
Without co-morbidity	1,517 (84.5%)
Health personnel mix type, n (%)	
With physicians and pharmacists	1,297 (72.3%)
Without physicians and pharmacists	498 (27.7%)
Fasting blood glucose level (mg/dl)	
Mean (SD)	147.84 (46.65)
Min, Max	46, 415
Median (IQR)	138.00 (50.00)
Controllability in FBG level***, n (%)	
Controllable	732 (40.8%)
Uncontrollable	1,063 (59.2%)

* FBG-measured group is type 2 diabetes' files with available information on age, gender, weight, height, and FBG level
** The standard range of BMI is 18.5-22.9 kg/m^2
*** The controllability in FBG level is the patients' FBG levels were between 70 and 130 mg/dl

Table 2. Comparison between patients with controllable and uncontrollable diabetes assessed by fasting blood glucose level (FBG-measured group)*

Factors	Controllable group** (n = 732)	Uncontrollable group** (n = 1,063)	p-value
Age, years			<0.001
Mean (SD)	61.49 (11.28)	58.89 (11.0)	
Min, Max	22, 90	26, 88	
Median (IQR)	62.0 (16.0)	59.0 (16.0)	
Gender, n (%)			0.865
Male	219 (40.5%)	322 (59.5%)	
Female	513 (40.9%)	741 (59.1%)	
BMI group, n (%)			0.148
Within standard range***	202 (43.6%)	261 (56.4%)	
Lower/higher than standard range***	530 (39.8%)	802 (60.2%)	
Co-morbidity, n (%)			0.727
With co-morbidity	116 (41.7%)	162 (58.3%)	
Without co-morbidity	616 (40.6%)	901 (59.4%)	
Health personnel mix type, n (%)			<0.01
With physicians and pharmacists	574 (44.3%)	723 (55.7%)	
Without physicians and pharmacists	158 (31.7%)	340 (68.3%)	

* FBG-measured group is type 2 diabetes' files which have information of age, gender, weight, height and FBG level
** Controllability in FBG level is the patients' FBG levels were between 70 and 130 mg/dl
*** The standard range of BMI is 18.5-22.9 kg/m^2

mix type with physicians and pharmacists available were also similar as of 72.3% in FBG-measured group and 76.9% in HbA_{1c}-measured group. Average blood glucose levels were also similar in FBG-measured group and HbA_{1c}-measured group, or 147.84 and 149.30 mg/dl. Regarding glycemic controllability, the proportion of controllable patients measured by FBG were more than those patients measured by HbA_{1c} level (40.8% vs. 22.7%). The average HbA_{1c} level in HbA_{1c}-measured group was 7.74%.

Table 4 shows that age of DM patient groups was the only factor which was significantly associated with glycemic controllability using HbA_{1c} ($p = 0.012$). Other variables were not found to be statistically significant. The multivariate analysis confirmed the results. Age was the only factor (OR = 1.023; 95% confidence interval 1.003-1.044) significantly predictive for diabetes care using HbA_{1c}.

Discussion

The present study shows the average FBG level was 147.84 mg/dl in FBG-measured group and average HbA_{1c} level was 7.74% in HbA_{1c}-the measured group. No result of FBG level was found in other studies as a tool to measure the DM care effectiveness. The average HbA_{1c} value in the present study (7.74%) was higher than glycemic controllability cut point, which is similar to a study in the United States that revealed average HbA_{1c} value of 7.6%[14]. However, this was different from studies in Jordan (7.1%) and Canada (7.3%)[8,15]. The present study demonstrated that the diabetes care at primary care setting had poor glycemic control and this effectiveness was confirmed that only 22.7% of patients had HbA_{1c} level less than 7.0%. The glycemic controllability from the present study was lower than reports from many previous studies in other countries such as the United States, Canada and Jordan (40.5%, 51% and 56.1%)[8,14,15]. To improve patients' glycemic controllability, the useful health program such as self monitoring of blood glucose (SMBG) should be set up as a recommendation from many studies[12,16,17].

In the present study the results did not reveal only patients who were able to control HbA_{1c} level (22.7%) but the effectiveness of the ability to control FBG level (40.8%) was also shown. These figures were apparently different. It may have been caused from the patients who tried to control blood glucose level by eating less during a few days before coming to see the health personnel. That made the higher glycemic controllability among the FBG level group than HbA_{1c} group. The reason is that the

Table 3. Characteristics of 542 type 2 diabetes patients whose glycemic controllability was assessed by HbA_{1c} level

Characteristics	HbA_{1c}-measured group *
Age, years	
Mean (SD)	60.04 (10.85)
Min, Max	31, 88
Median (IQR)	60.00 (15.00)
Age group, years n (%)	
< 40	21 (3.9%)
41-50	86 (15.8%)
51-60	181 (33.4%)
61-70	161 (29.7%)
> 70	93 (17.2%)
Gender, n (%)	
Male	152 (28.1%)
Female	390 (71.9%)
BMI (kg/m^2)	
Mean (SD)	26.08 (4.73)
Min, Max	14.53, 58.68
Median (IQR)	25.35 (5.61)
BMI group, n (%)	
Within standard range**	122 (22.5%)
Lower/higher than standard range**	420 (77.5%)
Co-morbidity, n (%)	
With co-morbidity	83 (15.3%)
Without co-morbidity	459 (84.7%)
Health personnel mix type, n (%)	
With physicians and pharmacists	417 (76.9%)
Without physicians and pharmacists	125 (23.1%)
Fasting blood glucose level (mg/dl)	
Mean (SD)	149.30 (44.08)
Min, Max	63, 359
Median (IQR)	140.00 (53.50)
Controllability in FBG level***, n (%)	
Controllable	214 (39.5%)
Uncontrollable	328 (60.5%)
HbA_{1c} level (%)	
Mean (SD)	7.74 (1.72)
Min, Max	4, 15
Median (IQR)	7.0 (2.0)
Controllability in HbA_{1c} level****, n (%)	
Controllable	123 (22.7%)
Uncontrollable	419 (77.3%)

* HbA_{1c}-measured group is type 2 diabetes' files with available information on age, gender, weight, height, FBG level and HbA_{1c} level

** The standard range of BMI is 18.5-22.9 kg/m^2

*** The controllability in FBG level is the patients' FBG levels were between 70 and 130 mg/dl

**** The controllability in HbA_{1c} level is the patients' HbA_{1c} levels were < 7.0%

result of FBG reflects average glycemic levels of the previous eight hours while the HbA_{1c} value represents more a realistic figure of over the past several months[12]. The glycemic control from FBG figures seems to look better than the HbA_{1c}, this might reflect the Thai health life styles. It should be recommended that health education especially self-monitoring on glucose level such as using glucose meter with test strips may solve this problem.

The current study showed that patients' age was associated with the effectiveness of glycemic controllability as measured by both FBG and HbA_{1c} levels and were confirmed by the odds ratio from multivariate analyses. This finding was similar to the previous studies[9,18]. One possible explanation was that older diabetes patients might have significant impairment of pancreatic insulin secretion as reported by Meneilly, Dawson and Tessier[19]. Furthermore, the older patients might have more leisure time and more concern of their health. Therefore, the younger DM patients might be the target group for monitoring glycemic control and giving heath education on diabetes.

Another important result from the present study is that the odd-ratio for personnel mix type demonstrated that the effectiveness of glycemic controllability measured by FBG of the patients treated at primary settings with physicians and pharmacists were better than those treated at primary settings without physicians and pharmacists. This was consistent with other studies[20-24] in which their findings revealed a high percentage of diabetes patients treated by physicians and pharmacists achieving glycemic control goals. The results could be in part explained by the role of the health professionals related with diabetes medication. Physicians played a role in prescribing and adjusting the diabetes medication while pharmacists were responsible in dispensing the medication and providing drug information. Many studies showed the results that medication was associated with glycemic controllability in diabetes patients[9,23,25]. This finding would explain the effectiveness of diabetes care in primary care settings that have health professionals available and this would be congruent with the government policy of distribution of physicians and pharmacists to work with nurses and community health workers at primary care settings[26].

However, the findings of glycemic controllability measured by HbA_{1c} were not significantly different between two primary settings

Table 4. Comparison between patients with controllable and uncontrollable diabetes assessed by HbA_{1c} level (HbA_{1c}-measured group)*

	Controllable group** (n = 123)	Uncontrollable group*** (n = 419)	p-value
Age			0.012
Mean (SD)	62.24 (11.33)	59.39 (10.62)	
Min, Max	36, 88	33, 86	
Median (IQR)	61.0 (16.0)	59.0 (14.0)	
Gender, n (%)			0.210
Male	29 (19.1%)	123 (80.9%)	
Female	94 (24.1%)	296 (75.9%)	
BMI, n (%)			0.290
Within standard range***	32 (26.2%)	90 (73.8%)	
Lower/higher than standard range***	91 (21.7%)	329 (78.3%)	
Co-morbidity, n (%)			0.097
With co-morbidity	13 (15.7%)	70 (84.3%)	
Without co-morbidity	110 (24.0%)	349 (76.0%)	
Health personnel mix type, n (%)			0.739
With physicians and pharmacists	96 (23.0%)	321 (77.0%)	
Without physicians and pharmacists	27 (21.6%)	98 (78.4%)	

* HbA_{1c}-measured group is type 2 diabetes' files which have information of age, gender, weight, height, FBG level and HbA_{1c} level
** Controllability in HbA_{1c} level is the patients' HbA_{1c} levels were < 7.0%
*** The standard range of BMI is 18.5-22.9 kg/m^2

of health personnel groups, with or without health professionals. The authors suggest that the policy would not only emphasize on health personnel providing diabetes care but would also focus on implementation a comprehensive treatment including the behavior changes especially in term of diet control, patients' education as was recommended by ADA[12].

Unsurprisingly, gender, co-morbidity and BMI were not associated with glycemic controllability as shown by other studies[18,19,27,28].

In conclusion, glycemic controllability among diabetes patients at primary care setting in Thailand was lower than that from previous studies in other countries. The DM care in primary care setting should be concerned more than previously especially in health education and self-monitoring of blood glucose and HbA_{1c}. The personnel mix with physicians and pharmacists providing DM care was associated with the controllability. The policy makers should consider placing physicians and pharmacists in primary care settings. While this would be a challenge for the policy makers to develop such a strategy and to implement this policy, it would provide better treatement to the affected people.

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Potential conflicts of interest

None.

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ปัจจัยที่มีความสัมพันธ์กับประสิทธิผลในการดูแลผู้ป่วยเบาหวานของสถานบริการสาธารณสุขระดับปฐมภูมิ

ธีรพร สถิรอังกูร, สุคนธา คงศีล, ภูษิตา อินทรประสงค์, จรรยา ภัทรอาชาชัย, สุขุม เจียมตน

วัตถุประสงค์: *เพื่อศึกษาปัจจัยที่มีความสัมพันธ์กับประสิทธิผลในการดูแลผู้ป่วยเบาหวานของสถานบริการสาธารณสุขระดับปฐมภูมิ*

รูปแบบการวิจัย: *การศึกษาเชิงพรรณนาแบบย้อนหลัง*

วัสดุและวิธีการ: *เก็บข้อมูลจากแฟ้มประวัติผู้ป่วยเบาหวานชนิดที่ 2 ที่มารับบริการที่สถานบริการสาธารณสุขระดับปฐมภูมิ 48 แห่ง จำนวน 1,795 แฟ้ม ตัวแปรที่ศึกษาคือคุณลักษณะ ดัชนีมวลกาย โรคแทรกซ้อนจากเบาหวาน ระดับน้ำตาลในเลือดของผู้ป่วยเบาหวาน และทีมบุคลากรสาธารณสุข (ทีมที่มีกับทีมที่ไม่มีแพทย์และเภสัชกร) ในจำนวนแฟ้มประวัติผู้ป่วยที่ศึกษานั้นได้ทบทวนระดับ HbA_{1c} ของผู้ป่วย จำนวน 542 แฟ้ม ประสิทธิผลของการดูแลผู้ป่วยเบาหวานวิเคราะห์จากความสามารถในการควบคุมระดับน้ำตาลในเลือดและระดับ HbA_{1c} ของผู้ป่วยเบาหวาน*

ผลการศึกษา: *ผู้ป่วยเบาหวานชนิดที่ 2 ที่มารับบริการที่สถานบริการสาธารณสุขระดับปฐมภูมิ สามารถควบคุมระดับน้ำตาลในเลือดได้ร้อยละ 40.8 ของจำนวนผู้ป่วย 1,795 ราย และคุมระดับ HbA_{1c} ได้ร้อยละ 22.7 ของจำนวนผู้ป่วย 542 ราย ผลการวิเคราะห์พหุตัวแปรยืนยันว่าปัจจัยที่มีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับความสามารถในการควบคุมระดับน้ำตาลในเลือดคืออายุและทีมบุคลากรสาธารณสุข ($p < 0.001$) และผลการวิเคราะห์ยังยืนยันอีกว่าปัจจัยที่มีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติกับความสามารถในการควบคุมระดับ HbA_{1c} ของผู้ป่วยคืออายุ ($p = 0.012$)*

สรุป: *อายุของผู้ป่วยเบาหวานมีความสัมพันธ์กับความสามารถในการควบคุมระดับน้ำตาลในเลือดและ ระดับ HbA_{1c} ของผู้ป่วย ทีมบุคลากรสาธารณสุขที่มีแพทย์และเภสัชกรมีความสัมพันธ์กับความสามารถ ในการควบคุมระดับน้ำตาลในเลือดเท่านั้น แต่ไม่มีความสัมพันธ์กับความสามารถในการควบคุมระดับ HbA_{1c} ของผู้ป่วยเบาหวาน*