Cost and Effectiveness of Screening Methods for Abnormal Fasting Plasma Glucose among Thai Adults Participating in the Annual Health Check-Up at King Chulalongkorn Memorial Hospital

Nipa Srichang MSc*, Wiroj Jiamjarasrangsi MD, PhD**,
Wichai Aekplakorn MD, PhD***, Siripen Supakankunti PhD****

** College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand*
*** Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand*
**** Community Medicine Center, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand*
***** Centre for Health Economics, Faculty of Economics, Chulalongkorn University, Bangkok, Thailand*

Background: *In Thailand, type 2 diabetes screening was implementing at national level by the Ministry of Public Health (MOPH) recommendation but screening methods have not been fully evaluated.*
Objective: *To compare the performance, cost, and cost-effectiveness of four screening methods in identifying individuals with abnormal fasting plasma glucose among Thai adults participating in the annual health check-up at King Chulalongkorn Memorial Hospital.*
Material and Method: *Individuals aged 35 to 60 years old with no known abnormal fasting plasma glucose (2,977 persons) were recruited. All subjects completed a set of screening questionnaires and were tested for venous fasting plasma glucose (FPG). One-time screening performance and costs were analyzed.*
Results: *Sensitivities of all screening methods ranged from 71 to 92%, while specificities were between 31 and 57%. The total costs of screening per one newly detected case were 59.12 to 69.62 US dollars (2,022 to 2,381 bahts). Compared to the universal FPG test, all screening methods using questionnaires were relatively more cost-effective. Their relative cost-effectiveness was, however, not obviously different.*
Conclusion: *Other factors should also be considered in selecting type 2 diabetes screening method for specific population in Thailand.*

Keywords: *Type 2 diabetes, Screening methods, Fasting plasma glucose, Cost*

J Med Assoc Thai 2011; 94 (7): 833-41
Full text. e-Journal: *http://www.mat.or.th/journal*

Type 2 diabetes is often insidious at its onset, without symptoms that would alert the patient or clinician. One study indicated an estimated 9 to 12 year delay in the disease diagnosis[1]. A large population (up to 50 percent) therefore remains undiagnosed[2,3]. The effects of type 2 diabetes are associated with substantial morbidity and mortality because of the damage to the eyes, kidneys, and nerves and acceleration of disease of the cardiovascular system[4]. Approximately 20% of patients with newly diagnosed type 2 diabetes had already developed the above complications at the time of diagnosis[5]. Therefore, early detection of subjects with abnormal fasting plasma glucose might be important in reducing the burden of complications of diabetes.

In Thailand, screening methods have been developed for detecting undiagnosed type 2 diabetes. These include (1) the method which was proposed by the Royal Medical Association of Thailand (RMAT)[6], (2) the method proposed by Thailand's Ministry of Public Health (MOPH)[7], (3) a diabetes risk score for predicting incident diabetes[8] and (4) the method proposed by Keesukphan et al[9]. However, the effectiveness of these methods has not been fully evaluated. Although type 2 diabetes screening has been implemented at the national level in Thailand using the

Correspondence to:
Jiamjarasrangsi W, Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand.
Phone: 0-256-4000 ext 3700, Fax: 0-2256-4292
E-mail: wjiamja@gmail.com

MOPH method since 2003[7,10], its cost-effectiveness in screening for undiagnosed type 2 diabetes in asymptomatic individuals is unknown and policy statements on this topic are controversial[3]. Thus, the aim of the present study was to compare the performance, cost, effectiveness and cost-effectiveness of four screening methods for abnormal fasting plasma glucose.

Material and Method

Study population

The study population included individuals between 35 and 60 years of age with no known diabetes or pre-diabetes who had participated in the annual health examination provided by the Preventive Medicine Clinic of the King Chulalongkorn Memorial Hospital between July and December 2008. All participants gave written consent before taking part in the present study. The protocols were approved by the ethics committee of the Faculty of Medicine, Chulalongkorn University.

Screening method

All subjects completed a set of screening questionnaires that included items for the four screening methods. Detail about the variables and the cut-off criteria for positive results for each screening method are summarized in Table 1. Those with positive results from the screening questionnaires were followed-up for fasting plasma glucose (FPG) testing after the 12-hour overnight fast. Universal venous FPG testing was also conducted and used as the reference for comparison with the other screening methods. One-time screening performance and costs were analyzed from both the single-payer and societal perspectives.

Definitions

Type 2 diabetes is defined according to the American Diabetes Association (ADA) criteria as FPG $\geq$ 126 mg/dl (7.0 mmol/l). In the present study, type 2 diabetes cases were subjects with FPG $\geq$ 126 mg/dl twice when tested at least 1 week apart. Impaired fasting glucose (IFG) or pre-diabetes was defined as those with FPG levels $\geq$ 100 mg/dl (5.6 mmol/l) but < 126 mg/dl (7.0 mmol/l)[11].

Abnormal fasting plasma glucose was defined according to the American Diabetes Association (ADA) criterion as individuals with an FPG $\geq$ 100 mg/dl (5.6 mmol/l)[11].

Statistical analysis

Sensitivity and specificity of four screening methods were determined at the different cut-off points for each method. The receiver operator characteristic

Table 1. Summary of 4 screening methods

Methods	Variable included	Criteria	Reference
1) The Royal Medical Association of Thailand (RMAT)	Age > 40 years old, body mass index (BMI) > 27 kg/m^2, family history of diabetes, previous delivery of large infant ($\geq$ 4,000 gm) or diagnosed with GDM, hypertension (BP $\geq$ 140/90 mmHg), history of HDL-C $\leq$ 35 mg/dl or triglyceride $\geq$ 250 mg/dl and IFG or IGT	The total score = 6 and cutoff-point $\geq$ 2	(6)
2) Thailand Ministry of Public Health	Age $\geq$ 35 years old, body mass index (BMI) $\geq$ 25 kg/m^2, family history of diabetes, previous delivery of large infant ($\geq$ 4,000 gm) or diagnosed with GDM, hypertension (BP $\geq$ 140/90 mmHg or history of hypertension), history of HDL-C $\leq$ 35 mg/dl or triglyceride $\geq$ 250 mg/dl and IFG or IGT	The total score = 6 and cutoff-point $\geq$ 2	(7)
3) Aekplakorn et al	Age, gender, BMI, waist circumference, hypertension (BP $\geq$140/90 mmHg or history of hypertension), history of diabetes in parent or sibling	Different weighing was applied to each variable with the total score = 17 and cutoff-point $\geq$ 6	(8)
4) Keesukphan et al	Age, BMI, history of hypertension	Different weighing was also applied to each variable and cutoff-point $\geq$ 240	(9)

(ROC) curves were then constructed by sensitivity plots against 1-specificity for each cut-off value as well as the area under the curve (AUC) to compare the impact of screening methods[12]. The likelihood ratio of a positive test result (LR+) was also determined for each screening method and used in the estimate of how much a test result would change the odds of having the disease. This ratio was calculated by dividing sensitivity with 1-specificity[13].

The measure for effectiveness of screening methods was the proportion of cases identified for abnormal fasting plasma glucose, which was also equal to sensitivity of the screening methods.

The cost of screening methods included both direct medical and non-medical costs of each method. Medical costs included laboratory tests, personnel time, and other material costs. Non-medical costs included patients' time and money spent for transportation to the hospital for clinical examinations.

The cost of the laboratory test was based on a previous study[14]. The cost of physician, nurse, and secretary's time was calculated from total salaries, including welfare expenditure. Transportation costs to a university hospital were obtained from the literature[15]. Patients' time was obtained from the Ministry of Labor[16]. All costs were expressed in Thai baht for the year 2008. Thus, the full cost of a screening method was calculated from the sum of total direct medical and non-medical costs. The cost-effectiveness (cost per case identified) was then calculated as the total cost of a screening method divided by the total number of cases identified. Detail analytical procedures and results were presented in the attached appendix.

Sensitivity analysis was performed for several factors that may have important effects on the present study outcomes. These factors include the variations in the prevalence rate of abnormal fasting plasma glucose, laboratory cost, patients' and personnel time and transportation cost. In this procedure, only a single item was changed from its baseline value, while other parameters were fixed[17].

All cost-analytical results were then transformed into United States (US) dollars by using the exchange rate of 34.20 baht per dollar[18].

Results

Subject characteristics

Two thousand nine hundred seventy seven respondents aged 35 to 60 years with no known diabetes or pre-diabetes were interviewed with a screening questionnaire in the Preventive Medicine Clinic at a university hospital. The majority of the respondents (73%) were women, with mean age of 46 years for both genders. Age-group compositions of male and female respondents were slightly different, except for the > 50 years age group-among which the proportions were similar for both genders (29%) (Table 2).

The average values of body mass index (BMI) for men and women were 25 and 23 kg/m^2, while the average waist circumferences were 85.34 $\pm$ 9.15 and 74.95 $\pm$ 9.98 cm respectively for both genders. The proportions of over-weight participants were 53.4 and 35.7% respectively for men and women.

Prevalence rates of high blood pressure were11.5 and 5.6% for men and women, while the proportions of those with a personal history of hypertension were 15.6 and 10.6% respectively. Frequencies of history of diabetes in parent or siblings were 37.3% among women and 31.8% among men.

Thirteen men (1.6% of men) and 18 women (0.9% of women) were diagnosed as diabetes, while 126 men (15.7%) and 163 women (7.5%) were diagnosed as IFG (Table 2).

Performances of screening methods

The overall sensitivities of all screening methods were high to very high and ranged between 71 and 92% for abnormal fasting plasma glucose screenings, while the overall specificities were low to moderate and ranged between 31 and 57% (Table 3).

Methods 4 (Keesukphan et al) and 2 (MOPH) had the highest sensitivity (92 and 89% respectively) but the lowest specificity (31 and 33% respectively) in abnormal fasting plasma glucose screening. On the other hand, Method 1 (The Royal Medical Association of Thailand (RMAT)) had the lowest sensitivity (71%) but the highest specificity (57%) for abnormal fasting plasma glucose screening. However, when the performance of screening methods was assessed by area under the ROC curves, Method 3 (Aekplakorn et al) performed the best in abnormal fasting plasma glucose screenings. This was due to its high sensitivity (83%) and moderate specificity (53%) compared to the other methods. The LR+ value was also highest for Method 3, followed by that value of Method 1.

The proportions of cases of abnormal fasting plasma glucose identified by different screening methods ranged from 71 to 92%. The number of cases of abnormal fasting plasma glucose detected by screening methods per 1,000 people screened ranged

Table 2. Baseline characteristics of the study population, according to gender

Characteristics	Men	Women
Number of subjects	803 (27)	2,174 (73)
Age (years)	45.99 ± 6.69	45.61 ± 6.83
Age group		
35-39	153 (19.1)	526 (24.2)
40-44	204 (25.4)	499 (23.0)
45-49	209 (26.0)	512 (23.6)
≥ 50	237 (29.5)	637 (29.3)
BMI (kg/m□)	25.09 ± 3.65	23.81 ± 3.93
BMI group		
< 23 kg/m^2	204 (25.4)	1,039 (47.8)
23-27.49 kg/m^2	429 (53.4)	776 (35.7)
≥ 27.5 kg/m^2	170 (21.2)	359 (16.5)
Waist circumference (cm)	85.34 ± 9.15	74.95 ± 9.98
Waist circumference ≥ 90 cm in men, ≥ 80 cm in women	239 (29.8)	658 (30.3)
BP ≥ 140/90 mmHg	92 (11.5)	122 (5.6)
History of hypertension	125 (15.6)	231 (10.6)
History of diabetes in parent or sibling	255 (31.8)	810 (37.3)
Previous delivery of large infant (≥ 4,000 gm)		66 (5.2)
Previously diagnosed with GDM		44 (3.4)
History of HDL-C ≤ 35 mg/dl	157 (26.8)	226 (14.1)
History of triglyceride ≥ 250 mg/dl	197 (31.0)	262 (15.1)
History of IFG 110-125 mg/dl	55 (8.9)	65 (3.8)
History of IGT 140-199 mg/dl	6 (8.3)	10 (6.6)
FBS, mg percent	91.67 ± 14.63	87.43 ± 12.79
DM	13 (1.6)	18 (0.8)
IFG	126 (15.7)	163 (7.5)

Data are means ± SD or number (percent)

Table 3. Performance of screening methods for screen-detected abnormal fasting plasma glucose

Screening methods	Sensitivity (%, 95Cl)	Specificity (%, 95Cl)	LR+	PPV (%)	NPV (%)	AUC (%, 95Cl)	Outcome per 1000 persons*		
							True positive	False positive	False negative
Method 1	71 (66-76)	57 (55-59)	1.74	14.96	94.77	68 (64-71)	69	391	28
Method 2	89 (85-93)	33 (31-35)	1.33	12.45	96.49	69 (66-72)	86	607	11
Method 3	83 (78-87)	53 (51-55)	1.76	15.98	96.63	73 (69-75)	81	421	16
Method 4	92 (89-95)	31 (29-33)	1.33	12.58	97.42	72 (69-75)	89	624	8
Universal FPG testing							97	-	-

* Data are number

AUC = area under the curve; LR+ = likelihood ratio of a positive test result; NPV = negative predictive value; PPV = positive predictive value

Method 1: screening method according to the recommendation of the Royal Medical Association of Thailand (RMAT)

Method 2: screening method according to the recommendation of Thailand Ministry of Public Health

Method 3: screening method according to Aekplakorn et al

Method 4: screening method according to Keesukphan et al

from 69 to 89, while the actual number of abnormal fasting plasma glucose cases was 97 per 1,000 persons screened. Method 4 was able to identify the highest proportion of cases, followed by Methods 2 and 3.

The proportion of cases missed ranged between eight and 28 cases per 1,000 persons screened for abnormal fasting plasma glucose. Method 1 missed the highest numbers of cases.

Cost of screening methods for abnormal fasting plasma glucose

The total costs (direct medical and non-medical costs) of screening for abnormal fasting plasma glucose per 1000 persons screened ranged from 4,684 to 6,754 US dollars (160,193 to 230,987 baht) from the societal perspective (Table 2). Methods 3 and 1 had the lowest total costs for detection of cases with abnormal fasting plasma glucose, while universal FPG testing had the highest cost, followed by Methods 4 and 2 respectively (Table 4).

The proportions of the persons requiring laboratory testing were higher in Methods 4 and 2 (713 and 693 persons per 1,000 persons screened) and lower in Methods 3 and 1 respectively (502 and 460 persons per 1,000 persons screened) (Table A-1).

Comparison cost-effectiveness of screening methods

The cost-effectiveness for identifying cases with abnormal fasting plasma glucose varied by screening methods. From a societal perspective and a single payer perspective, cost-effectiveness was 59.12- 69.62 and 26.64-34.68 US dollars/case (2,022-2,381 and 911-1,186 baht/case) respectively (Table 4). Method 3 had the highest cost-effectiveness, while universal FPG testing had the lowest cost-effectiveness. The number of persons needed to do FPG testing (which is an invasive procedure) for Method 3 was also fewer than Methods 2 and 4, although higher than Method 1 (Table A-1).

Sensitivity analysis

Sensitivity analysis by varying the disease prevalence rates, the values of laboratory tests, the values of patients' time and total salaries of personnel, and transportation rates did not alter the previous conclusion regarding the relative cost-effectiveness among different screening methods (details not shown).

Discussion

Although all screening methods shared many similar variables in the screening criteria, there were some differences among them. While age, BMI, and hypertension were utilized in all screening methods, different cut-off points for these variables were applied. Pregnancy and delivery history, history of HDL-C $\leq$ 35 mg/dl or triglyceride $\geq$ 250 mg/dl, and history of high blood glucose, were included only in Methods 1 and 2. Gender and waist circumference were utilized only in Method 3. Furthermore, while different weights for each variable were applied in Methods 3 and 4, equal weights were used in Methods 1 and 2. The discrepancies in performance among these

Table 4. Total cost and cost-effectiveness of screening methods for abnormal fasting plasma glucose per 1000 persons from the societal perspective and the single payer perspective

Screening methods	Cases identified (number)	Societal perspective		Single payer perspective	
		Total direct medical and non-medical cost*	Cost-effectiveness (cost*/case)	Total direct medical cost*	Cost-effectiveness (cost*/case)
Method 1	69	4,684 (160,193)	67.87 (2,321)	2,081 (71,170)	30.18 (1,032)
Method 2	86	5,590 (191,178)	65.00 (2,223)	2,647 (90,527)	30.79 (1,053)
Method 3	82	4,847 (165,767)	59.12 (2,022)	2,183 (74,659)	26.64 (911)
Method 4	89	5,668 (193,846)	63.68 (2,178)	2,695 (92,169)	30.29 (1,036)
Universal FPG testing	97	6,754 (230,987)	69.62 (2,381)	3,363 (115,015)	34.68 (1,186)

* US dollar (Baht)

Method 1: screening method according to the recommendation of the Royal Medical Association of Thailand (RMAT)

Method 2: screening method according to the recommendation of Thailand Ministry of Public Health

Method 3: screening method according to Aekplakorn et al

Method 4: screening method according to Keesukphan et al

screening methods were attributed to these differences.

While the current cut-off points of ≥ 6 and ≥ 240 respectively for Methods 3 and 4 were used for the identification of type 2 diabetes high-risk persons, the researchers also used the same cut-off point for screening those at risk for abnormal fasting plasma glucose (FPG ≥ 100 mg/dl). The ability of Methods 3 and 4 to identify individuals with abnormal fasting plasma glucose was lower than that for type 2 diabetes in the original study (the present study's AUC = 0.73 and 0.72 for Methods 3 and 4 respectively vs. the originally reported AUC= 0.74)[8,9]. Therefore, the cut-off points should be modified when these two methods are used for the identification of individuals with abnormal fasting plasma glucose instead of type 2 diabetes.

Two aspects of screening methods to be considered are false negative and false positive cases. False positivity results in a higher percentage of persons requiring laboratory testing, whereas false negativity causes some abnormal or diseased cases to go undetected and therefore, lose the ability to receive the benefits of appropriate and timely treatment to reduce the risk for type 2 diabetes or disease complications.

False negative cases may be quantified as the number of cases or in monetary terms. However, due to the scarcity of information for translating false negative cases into monetary terms, the data were presented as the number of cases. The number of false negative cases in the present study ranged from eight to 28 cases per 1,000 persons screened for abnormal fasting plasma glucose. Thus, Methods 2 and 3 should be selected based on the lower false negative cases. The problem of false negativity could be managed by continuing the periodic screening program that will detect false negative cases in the later period.

For false positive cases, the number ranged from 391 to 624 cases per 1,000 persons screened for abnormal fasting plasma glucose. Method 4 had the highest number of false positive cases followed by Method 2. A high level of false positivity should be managed by increasing the specificity of the screening method. Therefore, Method 3 should be selected based on its relatively high specificity and lower number of false positive cases.

Although the present study was conducted in the university hospital setting, its results can also be applied in smaller hospitals and the community. Costs of laboratory testing and personnel time may differ in these settings. However, sensitivity analysis has shown that the conclusion about the relative cost-effectiveness ratio of the screening methods remained unchanged when these costs are changed.

Since there is evidence that early detection of pre-diabetes and type 2 diabetes can prevent or delay disease development and progression, the screening program might be implemented at the national level. The authors estimate the performance and cost of a national screening program for abnormal fasting plasma glucose based on Method 3, which is the most cost-effective screening method available for the Thai population. The authors referred to previous studies for the prevalence of pre-diabetes and type 2 diabetes[2] and to the results of population projections for Thailand 2005-2025 for the number of the target population who are 35 years old and over in 2008[19]. The estimated numbers of newly identified cases of abnormal fasting plasma glucose among Thai adults who are 35 to 59 years or ≥ 35 years old, as well as the corresponding total cost are presented in Table 5.

From a societal perspective, the total cost (in the first year) of the national abnormal fasting plasma glucose screening program would range from 227.8 to 319.4 million US dollars (7,789.2 to 10,920.5 million bahts) if the target population is defined as those aged 35 to 59 years and > 35 years old respectively.

Compared with a universal blood test, Method 3 would save screening costs in the amount of 99.6 to 128.4 million US dollars or 3,406.3 to 4,391.3 million baht (29%) if the target populations are those who are 35-59 and > 35 years old respectively. Furthermore, when the number of people needed to do FPG test (which is an invasive procedure) is also taken into consideration. Method 3 seemed to be the most appropriate screening method.

Limitations of the present study included two repeated FPG of > 126 mg/dl was used as the gold standard instead of the 75 gm oral glucose tolerance test (OGTT). This might have resulted in the underestimate of type 2 diabetes prevalence. However, the OGTT is not practical on a large scale. Another limitation was that the study subjects were employees in public and private organizations. When the screening methods are applied to the general population with poor literacy, the performance of each screening method might be lower than the authors' reported performance. Furthermore, since the present study subjects included only those in 35 to 59 age range, the present study results might not be readily

Table 5. Estimated performance and total cost of a national abnormal fasting plasma glucose screening program for Thai adults

Screening method	Cases identified* (number)		Total cost (Societal perspective)**	
	35-59 years	≥ 35 years	35-59 years	≥ 35 years
Abnormal fasting plasma glucose				
Method 3	3,806,100	5,337,665	227.75 (7,789.15)	319.40 (10,923.48)
Universal FPG testing	4,585,663	6,430,922	319.31 (10,920.48)	447.802 (15,314.85)

* Case identified = total number of people aged 35 years and over X prevalence of abnormal fasting plasma glucose X sensitivity (Method 3 and Universal FPG testing)
** Total cost = the total number of cases identified X cost per case identified; presented in x million US dollars (x million Baht)
Method 3: screening method according to Aekplakorn et al

Table A-1. Resources used and unit values for abnormal fasting plasma glucose screening per 1,000 persons

Cost categories	Resources uses					
	Method 1	Method 2	Method 3 FPG testing	Method 4	Universal	Unit cost
Direct medical cost						
Screening questionnaire	1,000 x 1	1,000 x 1	1,000 x 1	1,000 x 1	0	B1/test
Physician time (1/4 h)*	460 x 70	693 x 70	502 x 70	713 x 70	1,000 x 70	B284/h
Nurse time (1/6 h)	1,000 x 28	1,000 x 28	1,000 x 28	1,000 x 28	1,000 x 28	B170/h
Secretary time (1/12 h)	1,000 x 4	1,000 x 4	1,000 x 4	1,000 x 4	1,000 x 4	B45/h
Laboratory test*	460 x 8	693 x 8	502 x 8	713 x 8	1,000 x 8	B8/test
Other direct costs (1 mail)*	460 x 5	693 x 5	502 x 5	713 x 5	1,000 x 5	B5/mail
Non-medical cost						
Patients' time						B25/h
High score persons (4 h)*	460 x 100	693 x 100	502 x 100	713 x 100	1,000 x 100	
Low score persons (2 h)	540 x 50	307 x 50	498 x 50	287 x 50	0	
Transportation cost (1 trip)	1,000 x 1	1,000 x 1	1,000 x 1	1,000 x 1	1,000 x 1	(B16/trip)
Total cost (baht)	160,180	191,169	165,766	193,829	231,000	
Case identified (number)	69	86	81	89	97	
Cost-effectiveness (baht/case)	2,321.45	2,222.90	2,046.49	2,177.85	2,381.44	

B = baht, h = hour
* Number of subjects who test positive score
Method 1: screening method according to the recommendation of the Royal Medical Association of Thailand (RMAT)
Method 2: screening method according to the recommendation of Thailand Ministry of Public Health
Method 3: screening method according to Aekplakorn et al
Method 4: screening method according to Keesukphan et al

applicable to the population of younger than 35 and older than 60 years old. These issues need further investigation.

Conclusion

In conclusion, although the screening method proposed by Aekplakorn et al was the most effective and had the highest cost-effectiveness for identifying newly detected cases for abnormal fasting plasma glucose among Thai adults, it was not obviously more effective than other screening methods. Factors such as principal purpose of screening and ease of administration should be considered in selecting type 2 diabetes screening method for specific population

in Thailand. However, taking into consideration the fewer number of people needed for an invasive FPG test, Aekplakorn et al proposed method seemed to be the most appropriate nowadays.

Acknowledgements

This study is part of a larger research project supported by a grant from the National Research Council of Thailand (NRCT) via contract number ภค./2551-148 of the 2552 BE budget year.

References

1. Harris MI, Klein R, Welborn TA, Knuiman MW. Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis. Diabetes Care 1992; 15: 815-9.
2. Aekplakorn W, Abbott-Klafter J, Premgamone A, Dhanamun B, Chaikittiporn C, Chongsuvivatwong V, et al. Prevalence and management of diabetes and associated risk factors by regions of Thailand: Third National Health Examination Survey 2004. Diabetes Care 2007; 30: 2007-12.
3. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. Diabetes Care 1998; 21: 1414-31.
4. Nathan DM. Long-term complications of diabetes mellitus. N Engl J Med 1993; 328: 1676-85.
5. Davis TM, Stratton IM, Fox CJ, Holman RR, Turner RC. U.K. Prospective Diabetes Study 22. Effect of age at diagnosis on diabetic tissue damage during the first 6 years of NIDDM. Diabetes Care 1997; 20: 1435-41.
6. Suthijumroon A. Diabetes mellitus screening. In: Suntorntham S, editor. Evidence-based clinical practice guideline periodic health examination and maintenance in Thailand. Bangkok: Mohchaoban Press; 2001: 124-31.
7. Bureau of Non-communicable Diseases, Department of Disease Control, Ministry of Public Health, Thailand. Screening for hypertension and diabetes. Nonthaburi: Bureau of Non-communicable Diseases; 2007.
8. Aekplakorn W, Bunnag P, Woodward M, Sritara P, Cheepudomwit S, Yamwong S, et al. A risk score for predicting incident diabetes in the Thai population. Diabetes Care 2006; 29: 1872-7.
9. Keesukphan P, Chanprasertyothin S, Ongphiphadhanakul B, Puavilai G. The development and validation of a diabetes risk score for high-risk Thai adults. J Med Assoc Thai 2007; 90: 149-54.
10. Wibulpolprasert S. Thailand health profile 2001-2005. Nonthaburi: Express Transportation Organization; 2005.
11. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2006; 29 (Suppl 1): S43-8.
12. Fletcher R, Fletcher S, Wagner E. Clinical epidemiology: the essential. 3rd ed. Baltimore: Williams & Wilkins; 1996.
13. Jekel JF, Katz DL, Elmore JG. Epidemiology, biostatistics, and preventive medicine. 2nd ed. Philadelphia: Harcourt Health Sciences; 2001.
14. Charuruks N, Chamnanpai S, Seublinvog T. Cost analysis of laboratory tests: a study of the Central Laboratory of King Chulalongkorn Memorial Hospital. J Med Assoc Thai 2004; 87: 955-63.
15. Department of Land Transport, Ministry of Communications, Thailand. Transportation fee Bangkok [database on the Internet]. 2008 [cited 2009 Mar 6]. Available from: http://www.dlt.go.th
16. Ministry of Labour, Thailand. Minimum wage [database on the Internet]. 2008 [cited 2009 Mar 6]. Available from: http://www.mol.go.th
17. Limwattananon S. Handling uncertainty of the economic evaluation result: sensitivity analysis. J Med Assoc Thai 2008; 91 (Suppl 2): S59-65.
18. Bank of Thailand. Daily foreign exchange rates [database on the Internet]. 2009 [cited 2009 Mar 6]. Available from: http://www.bot.or.th/english/statistics/financialmarkets/exchangerate/_layouts/Application/ExchangeRate/ExchangeRate.aspx
19. Institute for Population and Social Research, Mahidol University. Results of population projections for Thailand 2005-2025 [database on the Internet]. 2009 [cited 2009 Mar 26]; Available from: http://www.ipsr.mahidol.ac.th

ต้นทุนและประสิทธิผลของวิธีการตรวจคัดกรองระดับน้ำตาลในเลือดหลังอดอาหารผิดปกติในประชากรไทยวัยผู้ใหญ่ที่ตรวจสุขภาพประจำปี ณ โรงพยาบาลจุฬาลงกรณ์

นิพา ศรีช้าง, วิโรจน์ เจียมจรัสรังษี, วิชัย เอกพลากร, ศิริเพ็ญ ศุภกาญจนกันติ

ภูมิหลัง: *ประเทศไทยได้ดำเนินการตรวจคัดกรองโรคเบาหวานชนิดที่ 2 ในระดับประเทศโดยคำเสนอแนะของกระทรวงสาธารณสุข แต่ยังไม่มีการประเมินวิธีการคัดกรองอย่างเพียงพอ*

วัตถุประสงค์: *เพื่อเปรียบเทียบสมรรถนะ ต้นทุน และต้นทุน-ประสิทธิผลของวิธีการตรวจคัดกรอง 4 วิธีเพื่อค้นหาผู้ที่มีระดับน้ำตาลในเลือดหลังอดอาหารผิดปกติในประชากรวัยผู้ใหญ่ที่ตรวจสุขภาพประจำปี ณ โรงพยาบาลจุฬาลงกรณ์*

วัสดุและวิธีการ: *กลุ่มตัวอย่างประกอบด้วยผู้ที่มีอายุ 35 ปี ขึ้นไปที่ไม่เคยมีประวัติระดับน้ำตาลในเลือดหลังอดอาหารผิดปกติ (จำนวน 2,977 คน) กลุ่มตัวอย่างทุกรายตอบแบบสอบถามคัดกรองชุดหนึ่งแล้วตามด้วยการตรวจระดับน้ำตาลในเลือดหลังอดอาหาร จากนั้นทำการวิเคราะห์สมรรถนะและต้นทุนสำหรับการตรวจคัดกรองรอบเดียว*

ผลการศึกษา: *พบว่าค่าความไวของการตรวจคัดกรองทั้งทุกวิธีอยู่ระหว่างร้อยละ 71 ถึง 92 ส่วนค่าความจำเพาะอยู่ระหว่างร้อยละ 31 ถึง 57 ต้นทุนรวมของการค้นหาผู้มีระดับน้ำตาลในเลือดหลังอดอาหารผิดปกติ 1 ราย อยู่ระหว่าง 59.12 ถึง 69.62 ดอลลาร์สหรัฐ (2,022 ถึง 2,381 บาท) วิธีการคัดกรองทุกวิธีมีต้นทุน-ประสิทธิผลดีกว่าการตรวจระดับน้ำตาลในเลือดหลังอดอาหารทุกราย อย่างไรก็ตามต้นทุน-ประสิทธิผลของการตรวจคัดกรองแต่ละวิธีไม่แตกต่างกันอย่างมีนัยสำคัญ*

สรุป: *ควรมีการคำนึงถึงปัจจัยอื่น ๆ ด้วยในการเลือกวิธีการคัดกรองโรคเบาหวานชนิดที่ 2 ในประชากรจำเพาะกลุ่มในประเทศไทย*