Benefits and Constraints in Screening for Non-Communicable Diseases in the Rural Area of Thailand's Northeast

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Objective: *To investigate the benefits and constraints of a screening attempt as initiated by the Ministry of Public Health (MoPH) measuring over-nutrition, hypertension and type 2 diabetes mellitus (T2DM) undertaken by the local health officials on sub-district level.*
Material and Method: *Capillary blood glucose (CBG), body mass index (BMI), blood pressure, and history of type 2 diabetes mellitus (T2DM) of first degree relatives was assessed following the direction of the Ministry of Public Health (MoPH) by the local health officials.*
Results: *The proportions of obesity, hypertension, and T2DM from 7,698 villagers were about 35%, 20%, and suspected to be 9%, respectively. This was similar to previous investigations except for the history of T2DM of first-degree relatives, which strongly relates to elevated CBG levels. A high percentage of missing value was recognized for all variables.*
Conclusion: *The screening of non-communicable disease program executed by the lower level of the health delivery system is an achievement by itself. It can detect new cases of diseases. However, incompleteness of variables is a constraint observed due to high workload of the health staff. To decrease the burden of the public health staff and the curative sector and increase accuracy, the proportion of the population eligible for screening should be restricted to a higher age, being obese, and having a first-degree relative with diabetes mellitus.*

Keywords: *Screening, Over-nutrition, Hypertension, Diabetes, Thailand*

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Like other low and middle-income countries, the health delivery system of Thailand is challenged by the double burden of coping with infectious and non-communicable diseases at the same time[1]. In the past Thailand was quite successful in controlling a number of infectious diseases and in improving mother and child health care[2,3] by following the primary health care initiative as inaugurated at the Alma Ata meeting decades ago[4]. The Ministry of Public Health (MoPH) reacted to the 'epidemiological transition' in a similar way like for the former primary health care attempts by trying to curb the increasing incidence of non-communicable diseases. Many initiatives routine screening measures were launched assessing conditions due to the so-called nutritional transition[5] resulting in over-nutrition, an increase of the prevalence of type 2 diabetes mellitus (T2DM), and hypertension.

Screening is done by the health staff at sub-district level supported by the communities through village health volunteers (VHV) and supposed to be supervised by health officials from the higher level of the public health administration. Yet the results of such an attempt are usually not evaluated and at best, raw data are reported to the higher level of the health delivery system and hardly communicated as scientific papers in the relevant literature. Instead, well designed 'operational' studies simulating part of the procedures are launched by the academic sector trying to avoid flaws and mistakes in conducting the projects and by this missing to detect constraints faced by those who have to perform routine measures in the field.

To improve the routine measures related to 'community based intervention' in a real world setting' as termed by Simmons et al 2010[6], it is necessary not only to consider the result of the screening measure

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but also to evaluate the achievements and the constrains of the initiative. The present investigation assessed the outcome of a routine screening attempt in a northeastern district of Thailand based on the information and data collected by the health officials at sub-district level. The objective was not only to report the proportion of over-nutrition and obesity, hypertension, and capillary blood glucose (CBG) values indicative of T2DM but also to identify flaws in conducting the screening and constraints faced by those working with the communities.

Material and Method

Setting

The routine screening at the Na Klang district was conducted in 2009. The area is one district of the Nong Bua Lamphu province in the Northeast of Thailand. The estimated overall population amounts to 91,000 inhabitants living in 131 villages within eight sub-districts. The lowest governmental health service level consists out of 13 primary care units (PCU). The PCU staff closely collaborates with village health volunteers (VHV) who are supposed to support the staff of the PCU in their health related activities such as informing and motivating villagers to collaborate in the screening attempts. Villagers are investigated within their villages. Those found having capillary blood glucose (CBG) values indicative of impaired glucose tolerance (IGT) are asked to consult the PCU responsible for their village after six months and those with CBG values indicative of T2DM are advised to visit the diabetes outpatient clinic at the district (community) hospital where the diagnosis is verified by taking venous blood to determine venous blood glucose (VBG). A similar procedure is suggested to those with prehypertensive blood pressure, namely consulting the next PCU after six months, and those found with hypertensive blood pressure values are asked to visit the community hospital after the screening.

Procedures and study variables

The data of the present report was taken from the routine screening of diabetes at sub-district level. Sub-district health staff and village health volunteers had been trained for going through the screening attempt and a manual had been produced to assure an optimal quality of the procedures applied.

All together 7,698 villagers being cared for by 13 PCUs participated in the screening attempt. Those participating are supposed not to have been diagnosed with T2DM before, but if one or the other knowing already having the disease wants to be rechecked this time again, then this is not being refused. As stipulated by the MoPH the most feasible method for screening glucose levels CBG has been used. On the screening day, the community nurses took blood from the fingertip of the participants for CBG determination by the Roche ACCU-CHEK instrument and Advantage 11 Test Strips (Roche Diagnostics, Thailand). Calibration and quality control measures were followed as recommended by the supplier of the equipment. The accuracy of CBG measurement is periodically monitored by the laboratory of the community hospital (Na Klang Hospital). The CBG values of 6.1 to 6.9 mmol/L are indicative of IGT and those with a level of 7 mmol/L and above as T2DM to be verified at the community hospital measuring VBG. A systolic blood pressure of more than 120 mmHg but less than 140 mmHg was considered to indicate a prehypertensive condition and villagers with a systolic blood pressure of 140 mmHg and more were transferred to the community hospital of the district. Likewise, those with a diastolic blood pressure of over 80 mmHg were considered to be at risk and advised to have their blood pressure checked again after six months while those with a diastolic blood pressure of 90 mmHg and more were asked to visit the community hospital over the next few days. From weight and height measurement, the body mass index (BMI) (kg/m^2) was calculated[7]. Those with a BMI value of 22.9 and below were considered in a 'sufficient' nutritional status while a BMI of 23 to 24.9 indicated overweight and a BMI of 25 and above obesity. All cutoff points were in accordance with international standards[8-10].

Questionnaire

Besides recording age and sex, villagers were asked about their alcohol consumption and smoking habits by classifying the answers in 'no', 'quit' and 'regular'. Respondents also were asked whether their father or mother or another first-degree relative have or had T2DM and whether they already had been diagnosed having T2DM.

Data management and analysis

Data on a Microsoft Excel spreadsheet had been cleared and revised by the staff of the Department of Nutrition of the Faculty of Public Health, Khon Kaen University, Thailand. Data were transferred from the Excel program into a MINITAB Version 12 spreadsheet for further statistical evaluation. Variables had been

expressed as proportions as indicated in the tables. The ordinary chi-square test had been applied for testing statistically significant differences between groups. For testing associations, cross tabulations were performed and univariate as well as multivariate binary logistic regressions were calculated. For modeling, associations to CBG values by a multivariate binary logistic regression categories of the relevant variables were used as given in Table 4.

Ethical approval

The present article is a part of the project in the title of verification of diabetes screening results by using HbA1c as a standard that obtained ethical approval from the ethical committee of the Khon Kaen University (HE 532243). Taking blood from the finger prick of the voluntarily participating villagers is a routine measurement and was done by governmental health officials.

Results

General description

From the Na Klang district of the north-eastern province, Nong Bua Lamphu, 7,698 villagers participated. This number was confirmed by the answer about "sex", which was recorded with no missing values and corresponded to the identification numbers. For all other variables, missing values were noticed. The missing values in percent of the total number of participants are given for the variables displayed in Table 1 and 2. The effect of missing values on the statistical methods of cross tabulation and the binary logistic regression are indicated in Table 3 and 4.

The overwhelming majority of villagers are females with less than 40% being males (Table 1). The proportion of males in the age range of 61 years and older was significantly higher. In the age range of 43 years and lower, in comparison to females, the males taking part in the screening were slightly older than the females.

Alcohol consumption and smoking

The question about drinking and smoking was only answered from a minority of the respondents. From those who answered the question only 3% of females consumed alcoholic beverages regularly but about 30% of males admitted to drink alcohol regularly. From 3616 females, about 96% said that they do not smoke but from 2,142 males, about 27% smoked regularly.

First-degree relative with T2DM

Three thousand nine hundred thirty seven respondents seemed to remember whether either the

Table 1. Sex, age groups, alcohol drinking, smoking and history of type 2 diabetes mellitus from first degree relatives

Variable (missing values in %)	Total			Male			Female			p-value*
	n (total)	n	Percent	n (total)	n	Percent	n (total)	n	Percent	
Sex	7,698									
Male		2,855	37.1							
Female		4,843	62.9							
Age (years) (8.1)	7,074			2,616			4,458			<0.001
≤43		1,818	25.7		598	22.9		1,220	27.4	
44-60		3,561	50.3		1,339	51.2		2,222	49.8	
≥61		1,695	24.0		679	25.9		1,016	22.8	
Alcohol (37.7)	4,799			1,841			2,958			<0.001
No		4,008	83.5		1,204	65.4		2,804	94.8	
Quit		143	3.0		77	4.2		66	2.2	
Regular		648	13.5		560	30.4		88	3.0	
Smoking (25.2)	5,758			2,142			3,616			<0.001
No		4,869	84.5		1,400	65.4		3,469	95.9	
Quit		246	4.3		165	7.7		82	2.3	
Regularly		643	11.2		577	26.9		66	1.8	
DM relatives (48.9)	3,937			1,363			2,574			0.012
No		3,191	81.1		1.134	83.2		2,057	79.9	
Yes		746	18.9		229	16.8		517	20.1	

* Chi-square test males versus females

Table 2. Proportion of overweight, obesity, high blood pressure and prevalence of type 2 diabetes mellitus

Variable (missing values in%)	Total			Male			Female			p-value*
	n (total)	n	Percent	n (total)	n	Percent	n (total)	n	Percent	
BMI (kg/m^2) (3.5)	7,432			2,767			4,656			<0.001
≤22.9		3,266	44.0		1,435	51.8		1,831	39.3	
≥23		1,533	20.6		572	20.7		961	20.6	
≥25		2,624	35.4		760	27.5		1,864	40.1	
BPS (mmHg) (0.2)	7,684			2,851			4,834			0.128
≤120		3,378	44.0		1,217	42.7		2,161	44.7	
>120		2,719	35.4		1,048	36.8		1,671	34.6	
≥140		1,587	20.6		586	20.5		1,001	20.7	
BPD (mmHg) (0.2)	7,683			2,850			4,833			0.039
≤80		4,648	60.5		1,749	61.4		2,899	60.0	
>80		1,722	22.4		595	20.9		1,127	23.3	
≥90		1,313	17.1		506	17.7		807	16.7	
CBG (mmol/L) (1.7)	7,566			2,815			4,751			0.078
<6.1		6,466	85.4		2,436	86.5		4,030	84.8	
≥6.1		428	5.7		155	5.5		273	5.8	
>6.9		672	8.9		224	8.0		448	9.4	

* Chi-square test males versus females

Table 3. Diabetes known before screening and present screening results*

Variable	Total			DM not known			DM known			p-value**
	n (total)	n	Percent	n (total)	n	Percent	n (total)	n	Percent	
CBG mmol/L	5,862			5,715			147			<0.001
<6.1		4,879	83.2		4,820	84.3		59	40.1	
≥6.1		359	6.1		339	5.9		20	13.6	
>6.9		624	10.6		556	9.7		68	46.2	

* Each individual should have answered the question whether she or he has been diagnosed with T2DM already or not
** Chi-square test 'T2DM not known' versus 'T2DM known'

mother or the father, is or was, suffering from T2DM. Slightly less than 20% remembered a first-degree relative with the disease and the proportion of females with a T2DM relative with 20% exceed significantly the proportion of males with a diseased relative.

Overweight and obesity

When looking at weight of the 7,432 participants, 56% were either overweight (BMI 23-24.9) or obese (BMI ≥25). The nutritional status of females was worse in comparison to males. While at least about 52% of males were measured with a BMI lower than 23, indicating a 'sufficient' nutritional status, the proportion of females in this category was about 12%, lower than for the man. About 40% of the females had a BMI of 25 and above and by this classified as obese (Table 2).

Hypertension

The prevalence of hypertension did not differ between males and females in that approximately 35% were classified as prehypertensive and about 20% had systolic measurements of 140 mmHg or above. A slight but statistically significantly difference between males and females had been observed for diastolic blood pressure. About 20% were prehypertensive males less than females, and the proportion of males having a diastolic measurement of 90 mmHg and above was approximately 18% where the proportion for females were about 1% lower.

Type 2 diabetes mellitus

According to the results of CBG measurement, about 9% had to be classified as having T2DM while less than 6% had values considered to indicate IGT. For a cross tabulation of villagers screened for T2DM

Table 4. Multivariate binary logistic regression with CBG* as dependent variable and age, sex, diastolic blood pressure, systolic blood pressure, BMI, and DM relatives variables with categorical data as predictors

Predictors	OR (crude)	95% CI	OR (adj.)	95% CI	p-value
Age (years)					0.015
≤43	1		1		
≥44	1.42	1.08-1.89	1.41	1.07-1.86	
Sex					0. 287
Male	1		1		
Female	1.16	0.92-1.48	1.14	0.90-1.43	
DM relatives					<0.001
No	1		1		
Yes	1.70	1.35-2.14	1.70	1.33-2.16	
BPS (mmHg)					0.010
<140	1		1		
≥140	1.62	1.25-2.09	1.43	1.09-1.90	
BPD (mmHg)					0.191
<90	1		1		
≥90	1.58	1.17-2.11	1.23	0.90-1.69	
BMI (kg/m^2)					0.104
<25.0	1		1		
≥25.0	1.31	1.05-1.63	1.20	0.96-1.50	

* Log-likelihood = -1,145.426; DF = 6; p-value = 0.000; 3,312 (43% of 7,698 individuals under survey) cases were used; CBG 1 = ≤6.9 mmol/l, 2 = ≥7 mmol/L

the first time with villagers already known to have the disease a total of 5,862 individuals were available (Table 3). Out of this, 147 (3.5%) villagers already knew that they were diabetics. From 5,715 persons, 9.7% had CBG values over 6.9 mmol/L. From those 147 villagers who already knew that they had T2DM, 46% had CBG values over 6.9 mmol/L.

Factors related to capillary blood glucose

The crude odds ratio (OR) assessed by a binary regression indicated a significant correlation with CBG for all variables tested except sex, but only age, first-degree relative with T2DM, and systolic blood pressure significantly contributed to the multivariate binary logistic regression (Table 4).

Discussion

The screening results observed for the district under survey as far as health risks for non-communicable diseases are concerned could be expected and are another proof that the after effects of the epidemiologic transition is very much felt in the rural areas of the northeast of Thailand as well. The results of foregoing surveys through Thailand are comparable in its general trend to the observation made for the Na Klang District. A national survey in 2004 resulted in BMI values of 25 and above, indicating obesity, between 25% and 35%[11]. The somewhat higher proportion of obesity in women of 40% observed in this investigation might be due to the fact that the national survey included all individuals of 15 years and older whereas following the instruction of the MoPH individuals screened should not be younger than 35 years. Since obesity increases with age, the higher proportion found for women here might be due to the difference in age range of the population under study. Comparison of results from forgoing studies about hypertension with this investigation is hampered by the fact that the cutoff point for hypertension usually is chosen to be 130 mmHG[12,13] and not 140 mmHG as in this attempt. A more recent study about hypertension including over 1,000 villagers from a central area of Thailand using the same cutoff point as for Na Klang resulted in similar proportions of hypertension being over 20%. This investigation is considered to be an operational research investigating public health actions in the field by the staff of the health delivery system using the methods as ordered by the MoPH. The selection of CBG as screening tool was decided by the MoPH and could not be subject for change by the investigators. The proportion of villagers found with CBG values supposed to indicate IGT and

T2DM exceeded the values obtained from a national survey undertaken in 2004 by about 3 to 4%[12,13]. As mentioned above the inclusion of younger age groups into the national survey might explain the difference between the results reported here and the results of the national survey. Yet comparable prevalence rates to those reported here had been observed for a district at the neighboring province Khon Kaen with about 11%[13,14].

Beyond the expected results derived from the screening project the high proportion of screened individuals remembering having a first degree relative who suffer or suffered from T2DM is noteworthy, quite consisted and hardly can be brushed aside as 'recall bias' in view of the finding that those with a first degree relative are 1.7 times more at risk also to have CBG values supposed to indicate T2DM. Internationally it is discussed to include the variable indicative for a genetic disposition as risk indicator for screening[15] and not only record it in a descriptive way. Back in 1995, the importance of first-degree relatives for rural Thais had been already mentioned[16] and more recently the importance of first-degree relatives in identifying high-risk groups for T2DM in Thailand was pointed out[17]. Therefore, a strong genetic precondition of villagers for T2DM should be considered even in view of the general agreement that environmental factors might be more important than a genetic disposition[18-20].

Besides the significant contribution of 'having a first-degree relative with T2DM' only the systolic blood pressure significantly contributes to the model predicting CBG values of 7 mmol/L and above. The other variables except sex are significantly related to abnormal CBG measurements by univariate binary logistic regressions but seem to be confounders when tested by a multivariate regression. BMI might be confounded by weight and diastolic blood pressure by the systolic blood pressure. The failure of the variable 'sex' to significantly contributing to the multivariate model might be due to the high proportion of females over males volunteering in the screening attempt.

The successful inclusion of screening for risk factors of non-communicable diseases into the primary health care scheme of Thailand is one of the great achievements of the health delivery sector. A constraint of the project is the obvious lack of interest of males in participating in screening. It was not intended to follow up those identified to have suspicious CBG or blood pressure values, but the fact that more or less by chance it was detected that almost 50% of those know before the screening to have T2DM were found to have CBG values of 7 mmol/L and above gives reason to question about the compliance and care of the diseased living in the villages. Recently a nationwide survey gave reason to question the compliance of T2DM patients in caring for them[21]. The inconsistency in recording each variable for each participants resulting in a wide variation of missing values is another constraint observed in this investigation. While the percentage of missing values for the most important variables such as blood pressure and CBG measurements are low the calculation of BMI already seems to be a challenge in that the variable was not given for 3.5% of participants. Missing values reached almost 50% for the variable 'T2DM of first-degree relatives'. Obviously, there might be a flaw related to the questionnaire or the way answers were recorded in missing to record those who could not remember at all whether T2DM was ever diagnosed for family members.

The question for alcohol consumption and smoking likewise resulted in a high percentage of missing values. Quite a high number of villagers might be reluctant to admit drinking alcohol and smoking but in this case, it might be helpful to gain a better insight into the behavior by recording a 'no answer'.

Some constraints as mentioned above might be caused by inaccurate procedures followed by the field workers and lack of supervision from health officials at sub-district and district level. Other pitfalls are system immanent such as a supposed lack of adequate follow up of diseased villagers. It should be kept in mind that the health staff especially on sub-district level is grossly overworked and hardly can be blamed to see their major objective in caring for patients coming to their working place and less to collect information and data for which they actually are not trained in detail. The hospital staff also might be crossly burdened in dealing with the ever increasing flow of new patients to be checked for T2DM and hypertension. Using HbA1c as clinical reference it recently was detected that screening with CBG results in a sensitivity of less than 50% with a positive predictive value (PPV) of about 70% which means that from 100 patients coming to the hospital with a positive screening results 30 are actually not diseased, and by this increase the workload of the medical personal at the hospital. A similar low sensitivity was also measured for VBG as reported previously[22].

The great achievement of the screening scheme is that it actively approaches the villagers at

the community while in high-income country the primary care arm of the health delivery system cares for diabetic patients who seldom are identified through active screening attempt but detected either by chance after blood taking in the clinic of a medical doctor or the hospital or because cases with unrecognized T2DM are already suffering from the aftereffects of the T2DM for instance having already problems with their vision and then the ophthalmologist is the first one coming up with the diagnosis. For Thailand it might be considered to respond to limited resources of the health delivery system and increase the efficiency of the screening attempt in concentrating on a high-risk group identified by age, BMI and family history[15]. An additional consideration might be not to measure fasting glucose values but random capillary or plasma glucose[17,23]. However, before this can be discussed from the decision maker more operational research is necessary in order to define which age group should be eligible for screening, and what BMI value defines a high-risk and whether a family history of T2DM should be added as precondition to be eligible for screening. The hint that a genetic disposition plays a role in the occurrence is relevant but probably more research related to this issue would be of benefit.

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Potential conflicts of interest

None.

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ประโยชน์และข้อจำกัดของการตรวจคัดกรองโรคไม่ติดต่อในพื้นที่ชนบท ภาคตะวันออกเฉียงเหนือของประเทศไทย

เบญจา มุกตพันธุ์, ภัทระ แสนไชยสุริยา, สุวลี โล่วิรกรณ์, ธงไทย วรรณคีรี, แฟรงค์ พี เชลพ์

วัตถุประสงค์: *เพื่อศึกษาประโยชน์และข้อจำกัดของความพยายามในการตรวจคัดกรองโรคไม่ติดต่อเรื้อรัง ได้แก่ ภาวะโภชนาการเกิน ความดันโลหิตสูง และเบาหวาน ที่ริเริ่มโดยกระทรวงสาธารณสุข และดำเนินการโดยเจ้าหน้าที่สาธารณสุขระดับตำบล*

วัสดุและวิธีการ: *ตรวจวัดระดับกลูโคสในหลอดเลือดฝอย, ประเมินภาวะโภชนาการ, วัดความดันโลหิต, ซักประวัติการเป็นโรคเบาหวานชนิดที่ 2 ของญาติสายตรง ตามแนวทางที่กระทรวงสาธารณสุขกำหนดโดยเจ้าหน้าที่สาธารณสุขระดับตำบล*

ผลการศึกษา: *สัดส่วนภาวะอ้วนพบร้อยละ 35% ความดันโลหิตสูงพบร้อยละ 20% และโรคเบาหวานชนิดที่ 2 พบร้อยละ 9% ในประชาชนจำนวน 7,698 คน ซึ่งคล้ายคลึงกับผลการศึกษาก่อนหน้านี้ ยกเว้นผลที่พบว่าการมีประวัติการเป็นโรคเบาหวานชนิดที่ 2 ของญาติสายตรง มีความสัมพันธ์สูงกับการมีระดับกลูโคสในหลอดเลือดฝอยสูง นอกจากนี้พบการไม่มีค่าข้อมูล (missing value) ในร้อยละที่สูงในทุกตัวแปร*

สรุป: *การตรวจคัดกรองโรคเบาหวาน ความดันโลหิตสูง และโรคอ้วนที่ดำเนินการโดยเจ้าหน้าที่สาธารณสุขระดับตำบล สามารถบรรลุผลตามเป้าหมายโดยสามารถค้นหาผู้ป่วยรายใหม่ได้เพิ่มขึ้น แต่ยังมีปัญหาความสมบูรณ์ของข้อมูลเนื่องจากเจ้าหน้าที่มีภาระงานมาก ดังนั้นถ้าสามารถลดจำนวนคนที่ถูกคัดกรองโดยเพิ่มเกณฑ์สำหรับผู้ถูกคัดกรองได้แก่ กำหนดอายุที่สูงขึ้น อ้วน และมีญาติสายตรงเป็นโรคเบาหวาน จะทำให้ลดภาระของเจ้าหน้าที่สาธารณสุขอันอาจส่งผลให้ประสิทธิภาพของการคัดกรองดีขึ้น*