A risk scores for predicting prevalence of diabetes and pre-diabetes in the LAO population

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คะแนนความเสี่ยงเพื่อการคาดการณ์ ความชุกของโรคเบาหวาน และ ภาวะก่อนเบาหวาน ในประชากรลาว

นางสุภาพร หลวงดวงสิทธิเดช

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วัตถุประสงค์: เพื่อพัฒนาคะแนนความเสี่ยงเพื่อการคาดการณ์ความชุกของโรคเบาหวานและภาวะก่อนเบาหวานในประชากรลาว

วัสดุละวิธีการ: การศึกษาแบบ cross-sectional ในกลุ่มตัวอย่างจำนวน 1098 คน ของประชากรลาวอาศัยอยู่ชนบทในเวียงจันทน์ที่มีอายุระหว่าง 30 ถึง 70 ปี สร้างโมเดลทางสถิติโดยการวิเคราะห์ Multiple logistic regressions with backward stepwise selection และค่าคะแนนความเสี่ยงโรคเบาหวานและภาวะก่อนเบาหวานได้มาจากค่าสัมประสิทธิ์บีตา(β-coefficient)ที่เกี่ยวข้อง จากนั้นตรวจสอบประสิทธิภาพของคะแนนความเสี่ยงโดยการหาค่า Area under the receiver operating characteristic curve (AUC), sensitivity และ specificity สำหรับคะแนนจุดตัดที่เหมาะสมที่สุด

ผลการศึกษา: ความชุกของโรคเบาหวานและภาวะก่อนเบาหวานมีค่าเท่ากับร้อยละ 7 และร้อยละ 15.5 ตามลำดับ ปัจจัยที่อยู่ในโมเดลทำนายของ “คะแนนความเสี่ยงเบาหวาน” คือ 17 (อายุ > 40 ปี) + 14 (เส้นรอบเอวสูง) + 11 (ความดันโลหิตสูง) + 7 (ประวัติครอบครัวโรคเบาหวาน) และของ“คะแนนความเสี่ยงภาวะก่อนเบาหวาน” คือ 5 (อายุ > 40 ปี) + 5 (ความดันโลหิตสูง) +1 (ดัชนีมวลกาย) โดย“คะแนนความเสี่ยงเบาหวาน และ ภาวะก่อนเบาหวาน” มีคะแนนจุดตัดที่เหมาะสมที่สุดเท่ากับ 29.5 และ 5.5 จากคะแนนเต็ม 49 และ 12 คะแนน ซึ่งมีค่า sensitivity เท่ากับ .75 และเท่ากับ .76 ค่า specificity เท่ากับ .55 และเท่ากับ .54 และ ค่า AUC เท่ากับ .698 (p=.002) และเท่ากับ .682 (p=.0001) ตามลำดับ

สรุป: ผู้วิจัยได้พัฒนาคะแนนความเสี่ยงแบบง่ายเพื่อใช้ในการตรวจคัดกรองผู้ที่มีความเสี่ยงสูงต่อโรคเบาหวานและภาวะก่อนเบาหวานในประชากรชาวลาว อย่างไรก็ตาม ควรมีการศึกษาเกี่ยวกับความสามารถนำไปใช้ได้อย่างกว้างขวาง (generalizability) และความเชื่อถือได้ (validity) ของคะแนนความเสี่ยงนี้ในประชากรชาวลาวกลุ่มอื่นๆเพิ่มเติม

ภาควิชา	โภชนาการและการกำหนดอาหาร	ลายมือชื่อนิสิต .....
สาขาวิชา	อาหารและโภชนาการ	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....
ปีการศึกษา	2559	ลายมือชื่อ อ.ที่ปรึกษาร่วม .....

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SOUPHAPHONE LOUANGDOUANGSITHIDET: A risk scores for predicting prevalence of diabetes and pre-diabetes in the LAO population. ADVISOR: ASST. PROF.SUWIMOL SAPWAROBOL, DrPH, CO-ADVISOR: ASSOC. PROF.WIROJ JIAMJARASRANGSI, MD, Ph.D., pp.

Objective: To develop a risk scores for predicting the prevalent diabetes and pre-diabetes in Lao population.

Research design and methods: a cross-sectional investigation was conducted with 1098 subjects aged between 30 to 70 years of Lao population in Vientiane. Multiple logistic regressions with backward stepwise selection were utilized in the statistical modeling, and the diabetes and pre-diabetes risk score values were derived from the relevant β-coefficients. Performances of the scores were determined by the area under the receiver operating characteristic curve (AUC), sensitivity, and specificity for the optimal cut-off values.

Result: the prevalence of type 2 diabetes and pre-diabetes was 7% and 15.5 respectively. Factors included in the predictive model were 17 (> 40 of age) + 14 higher WC) + 11 (hypertension) + 7 (family history of diabetes) for “DM risk score” and 5 (> 40 of age) + 5 (hypertension) + 1 BMI for “Pre-DM risk score”. The cutoff point of “DM” and “Pre-DM” risk scores of 29.5 out of 49 and 5.5 out of 12 produced the optimal sum of sensitivity .75 and .76 , specificity .55 and .54, the AUC was .698 ($p < .002$) and .682 ($p < .0001$) in validation group respectively.

Conclusion: the researchers have developed a simple risk scores to be use in the screening in Lao population at high risk of diabetes and pre-diabetes. Their generalizability and validity for other Lao population, however, need further investigation.

Department:	Nutrition and Dietetics	Student's Signature .....
Field of Study:	Food and Nutrition	Advisor's Signature .....
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Chapter I
Introduction

1.1. Background

The International Diabetes Federation (IDF) 2013, indicated the prevalence of undiagnosed diabetes and pre-diabetes of Lao population aged 20 to79 years as 4.4% and 7.78% respectively [1]. The condition as mentioned above provides the burden problem in the impact of diabetes towards global development leads to rise in cost for the treatment. In 2014, there were 4.9 million deaths due to diabetes or every seven seconds a person died from diabetes worldwide [1]. It is estimated that the cost of treatment of diabetes worldwide will rise from 612.2 USD billion in 2014 to 627.3 USD billion by 2035. In Lao PDR, in 2013, the mean diabetes-related expenditure per person with diabetes was USD [1].

Diabetes is a chronic disease of which the cases lead to long term damage and socio-economic burden. In addition, 90% of cases were type 2 diabetes [2]. The type 2 diabetes is linear with the progression of morbidity and mortality, and its accounts for health care service worldwide [3]. The pre-diabetes indicated a progressive risk of type 2 diabetes progression on the or order over 4 years of 30% [4] and over 30 years of 70% [5].

The numbers of people who develop type 2 diabetes are increasing as mentioned above. The reasons for this developing of type 2 diabetes are still unclear. It might be due to many risk factors are associated with type 2 diabetes. Based on Gary S Collins et al [6] and Nicola Brown et al [7] reported the common risk factors have been used

to predict the type 2 diabetes prevalence categorized as non-modifiable factors and modifiable factors. The non-modifiable factors comprise of sex, age and family history of diabetes. Another one modifiable factors include body mass index, waist circumference, waist to hip ratio, hypertension, antihypertensive drug usage, physical inactivity, smoking, history of dyslipidemia (LDL, HDL, and triglyceride), and intake of the anti-dyslipidemia drug. In addition, female have history gestational diabetes, and history having birth weight more than or equivalence four kilograms are similarly take a role in the onset of type 2diabetes.

Some studies have convincingly shown that early interventions may delay or prevent the onset of type 2 diabetes [8, 9]. The reports showed that the undiagnosed type 2 diabetes was predicted by the screening of risk factors. The important step to delay or prevent the onset of type 2 diabetes and its complication is to classify people with pre-diabetes and undiagnosed diabetes consequently that they provide an appropriated care. To address this problem, several investigators have developed risk assessment model for type 2 diabetes in a simple, less expensive, more convenient and noninvasive method in order to predict the prevalence of type 2 diabetes.

Most people in Lao PDR are not so interested in assessing their health risk and doing medical check-up annually. As consequences, they have no clue of their current condition related to their blood glucose levels. In general, many of them having less motivation to do a routine check as well as the geographical area or location such as rural area makes them more difficult to access the health care services. However, this problem could be resolved by raising the awareness, participation or contribution from related sectors (government and private sector), along with adequate motivation of community.

After that, in Lao PDR, as compared to other countries, the development risk score for predicting undiagnosed diabetes prevalence have been not examined extensively. To our knowledge, risk assessment model may provide a possible better prediction in type 2 diabetes prevalence, particularly as undiagnosed diabetes in Lao population. Therefore, in this study, we aimed to develop risk scores for predicting undiagnosed diabetes prevalence in Lao population. We believe that early identification of undiagnosed diabetes using an appropriate screening risk score model for the certain population is a great of importance to prevent, delay and control of the onset type 2 diabetes. In addition, validation of risk score in high-risk population is also essential to be evaluated.

1.2. Objective

The aim of this study is to develop the risk score for predicting undiagnosed diabetes and pre-diabetes prevalence in Lao population. Specifically, objectives are:

1.2.1. to estimate undiagnosed diabetes and pre-diabetes prevalence by using fasting plasma glucose test in Lao population.

1.2.2. to develop undiagnosed diabetes and pre-diabetes risk score for predicting diabetes and pre-diabetes in Lao population

1.2.3. to validate undiagnosed diabetes and pre-diabetes risk scores in Lao population

1.3. Research Question

Are undiagnosed diabetes and pre-diabetes risk scores effective enough for predicting diabetes and pre-diabetes prevalence in Lao population?

1.4. Hypothesis

Diabetes and pre-diabetes risk assessment model using risk factors may pose a significant effect to develop the risk score for predicting diabetes and pre-diabetes prevalence in Lao population.

Chapter II
Literature review

2.1. Diabetes

2.1.1. Diabetes definition

Diabetes is a set of diseases indicated by the high level of blood glucose as consequences from deficiencies of insulin and/or defect in insulin sensitive. Type 2 diabetes generally initiates as insulin resistance, metabolism disorder in which the cells cannot use insulin appropriately. As the requirement for insulin increased, the pancreas slowly loses its ability to supply insulin [10].

2.1.2. Classification of diabetes

Diabetes is categorized into four types [10, 11]. First, type 1 diabetes is affected by an autoimmune destruction of the insulin-producing by the β cell of the islets of Langerhans in the pancreas or due to absolute insulin deficiency. It occurs nearly 5% of all diabetes cases in childhood or early adulthood. Second, type 2 diabetes as results of the defect in progressive insulin secretory caused by insulin resistance state. It presents mainly 90-95% of all diabetes cases in adults of middle age or elderly. Third, gestational diabetes raises diabetes which has been diagnosed during pregnancy. It accounts for about 2 to 10% of all diabetes cases and of them 35% of pregnant women with diabetes were progressed to type 2 diabetes. Fourth, another type of diabetes accounted for 1 to 5 % of all diagnosed cases as affected by particular genetic disorders (e.g. pancreatic disease, maturity-onset diabetes of surgery, infections, medications, youth, and other illnesses).

2.1.3. Criteria for diagnosed of diabetes

There is a major difference between screening and diagnostic testing for many illnesses. However, for diabetes, the same tests would be used for screening and diagnosis. Diabetes may be identified anywhere along a spectrum of clinical scenarios ranging from a seemingly low-risk individual who happens to have glucose testing, to a higher-risk individual whom the provider tests because of high suspicion of diabetes, to the symptomatic patient [12]. These are the criteria used in diagnostic testing of diabetes:

2.1.3.1. Fasting plasma glucose level >126 mg/dl which fasting is defined as no caloric intake for at least 8 hours; or

2.1.3.2. Two-hour plasma glucose level > 200 mg/dl during an oral glucose tolerance test or OGTT which the test should be done as described by the World Health Organization, using glucose load containing the equal of 75-gram anhydrous glucose dissolved in water; or

2.1.3.3. Glycated hemoglobin value (HgbA1C) > 6.5%. The test should be done in a laboratory using a method that is the National Glycohemoglobin Standardization Program (NGSP) certified and standardized to the Diabetes Control and Complication Trial (DCCT) assay and in the patient with classic symptoms of hyperglycemic or hyperglycemia crisis, a random plasma glucose > 200 mg/dl.

2.2. Undiagnosed diabetes

Definition of undiagnosed diabetes described as the presence of actual diabetes based on cut point of A1C $\geq$ 6.5% or OGTT $\geq$ 200 mg/dl or FPG $\geq$ 126 mg/dl, and the lack of an individual having been told he or she has diabetes [13].

As we know, criteria of glucose establish for the diagnosis of diabetes by fasting plasma glucose and OGTT remains valid yet. Analyses of the National Health and Nutrition Examination Survey (NHANES) data indicated that, assuming universal screening of the undiagnosed, the A1C cut point of ≥ 6.5% identifies one-third fewer cases of undiagnosed diabetes than a fasting glucose cut point of ≥ 126 mg/dl (7.0 mmol/L) [14], and numerous studies have confirmed that at these cut points the 2-h OGTT value diagnoses more screened people with diabetes [15]. However, in practice, a large portion of the diabetic population remains unaware of theirs condition.

The diabetes development of some older individuals have has years earlier and may be significantly associated complications; others who are newly diagnosed with undiagnosed diabetes may have had years with progression complications or may have truly recent-onset type 2 disease and few or no complications, the information from [16].

2.3. Prediabetes

Pre-diabetes was defined as a disorder in which individual have blood glucose, and/or A1C levels higher than standard but not high enough to be categorized as diabetes. Pre-diabetes individuals have an increased risk of developing type 2 diabetes, stroke, and heart disease [17]. There are several criteria of pre-diabetes [18]

2.3.1 the levels of impaired fasting glucose was 100 - 125 mg/dl,

2.3.2 and/or having IGT (2 hours of OGTT 140 - 199 mg/dl)

2.3.3 and/ or having A1C 5.7 - 6.4%.

It would be noted that the WHO and other diabetes establishments define the cutoff point the level of 110 mg/dl for impair fasting glucose.

2.4. Pre-diabetes and increased risk of diabetes

Having prediabetes is the term of the individual with impaired fasting glucose and/or impaired glucose tolerance, showing the reasonable progress for high-risk diabetes in the future. Impaired fasting glucose and impaired glucose tolerance would not be viewed as clinical entities in their own right but somewhat risk factors for diabetes as well as cardiovascular disease. Impaired fasting glucose and impaired glucose tolerance are related with [19] the low high-density lipoprotein cholesterol (HDL-c) and/or high triglycerides with dyslipidemia (triglycerides >250 mg/dl, LDL-C $\geq$ 100 mg/dl, HDL-c < 35 mg/dl), high blood pressure of 140/90 mmHg and/or intake hypertensive drug, and obesity (particularly visceral or abdominal obesity) [12]. As the consequence, the epidemic progress of overweight, abdominal obesity, and obesity, the number of newly diagnosed type 2 diabetes individual is estimated to increase sharply in the future years (439 million in 2030) [20].

American Diabetes Association suggests the testing to identify type 2 diabetes and prediabetes in asymptomatic individuals should be considered in adults of any age with risk factors (overweight or obesity as body mass index more than 25 kg/m^2 ; and individual have one or more risk factors such as physical inactivity, family history of diabetes (parents, sibling), high risk ethnicity/race(for example African, American, Asian American, Native American, Latino, Pacific Islander), female have history baby birth weighing >4 kg or gestational diabetes mellitus, female with polycystic ovary syndrome, other clinical conditions associated with insulin resistance (e.g. severe obesity, acanthosis Nigerians), history of cardiovascular disease (CVD).

While those have not risk factors, should begin testing at 45 years of age. If the result is normal should be repeated at least three intervals is reasonable of testing [13].

2.5. Delay or prevention of diabetes

American Diabetes Association (2013) stated that there are several recommendation for delaying or preventing the onset of diabetes according to the level evidence recommendation to delay or prevent the onset of diabetes according to the level evidence (A: Clear evidence from well-conducted, generalizable RCTs; B: Supportive evidence from well-conducted cohort or case-control studies; C: Supportive evidence from poorly controlled or uncontrolled studies; and E: Expert consensus or clinical experiences) as following information below [18]:

2.5.1. patients with IFG (E), or IGT (A), or 5.7 -6.4% of A1C (E) should be referred to an effective continuing promote program targeting 7% of weight loss of body weight and enhanced physical inactivity at least 150 min/week of moderate activity for example walking. Follow-up counseling appears to be important for success (B).

2.5.2. Based on the cost-effectiveness of diabetes prevention, such program should be covered by third-party payers (B)

2.5.3. Metformin therapy for prevention of type 2 diabetes may be considered in those with impaired glucose tolerance (A), impaired fasting glucose (E), or 5.7 -6.4% of A1C (E), especially for those with body mass index more than 35 kg/m^2, less than 60 years of age, female with prior gestational diabetes (A)

2.5.4. At least annual monitoring for the diabetes development in those with pre-diabetes is suggested (E)

2.5.5. Modifiable risk factors are suggested screening and treatment for CVD (B).

The previous studies (RCTs) have reported that high-risk individuals for progression type 2 diabetes (those with impaired fasting glucose, impaired glucose tolerance, or both) were significantly associated with decreased the rate of onset of type 2 diabetes with particular interventions [4, 21-26]. These include intensive programs of lifestyle modification that have been reported to be effective (nearly 58% reduction after 3 years)

2.6. Type 2 diabetes-associated risk factors

The variations of diabetes prevalence between countries and between rural and urban areas could be explained by differences levels of risk factors [27] such as age, gender, body mass index, and systolic of blood pressure. These risk factors for diabetes can be grouped into modifiable and non-modifiable risk factors. Lifestyle habits, culture, practices and health behaviors, for example, exercises and nutrition, are directly linked to diabetes prevalence and risk factors [28-32].

2.6.1. Age

The diabetes prevalence will twofold in the next twenty years, in part due to the population aging [33]. Other evaluations recommend that the number of diagnosed diabetes cases those more than equivalence 65 years of age will enhance by 4.5-fold (compare to 3-fold in the total population) between 2005 and 2050 [34]. The diabetes prevalence varies across age groups with significantly increasing prevalence with increasing age; a study in Ghana [35] reported that the diabetes prevalence was increased approximately six times in the older age categories; being similar to China

and Thailand in the age > 60 years [35, 36] and in a rural population in South Africa [37] and in Nigeria [38]. Some findings indicated that the lifestyle factors are more important than aging process alone.

2.6.2. Gender

There is a minor gender modification in the global sizes of people with diabetes for 2013 or 2035. There are about 14 million female less than male with diabetes (184 million female vs 198 million male). Though, this modification is predictable to rise to 15 million (288 million female vs 303 million male) by 2035 [39]. The differences above seem to correlate with the overall distribution of the risk factors, in that particular study population, such as obesity, smoking, older age, ethnic/racial groups, etc. Additionally, gender is confounded with lifestyle, for instance, a higher proportion of male smoke and tends to have higher central obesity than female; gender variances have been insufficiently examined between Asian American sub-groups using a population based demonstrative sample [14, 40-43]. Similar to the finding of variation from studies on the association of diabetes and gender across different study populations reported that the relationship between sex and diabetes in Thailand, China and different countries of Africa showed the higher prevalence of diabetes in males [35, 36, 38, 44, 45].

2.6.3. Family history of diabetes

A family history of diabetes is associated with a range of metabolic abnormalities [127] and is a strong risk factor for the development of type 2 diabetes. Previous studies [128-130] have been investigated the association of a family history of diabetes in different family members and age of familial diagnosis to the risk of type 2 diabetes in a large prospective case-cohort study of European individuals. As

the results [131], individuals with a family history of diabetes in any first degree family member were at higher risk of type 2 diabetes (HR 2.72, 95% CI 2.48to 2.99) and the presence of diabetes in different family members was associated with a similar hazard ratio (HR) of type 2 diabetes. Having a bi-parental family history was associated with a higher risk (HR 5.14, 95% CI 3.74to 7.07). Having any one family member with type 2 diabetes was associated with a 2.5-fold increase in risk of type 2 diabetes (HR 2.56, 95% CI 2.41to 2.72), whereas having two (HR 3.99, 95% CI 3.58to 4.43) or three family members (HR 5.73to 95% CI 4.28to 7.67) with type 2 diabetes was associated with an even higher risk.

2.6.4. Body mass index (BMI), waist circumference (WC), and wait to hip ratio (WHR)

The overweight and obesity defined as the abnormal fat accumulation that may impair health [46]. Major indicators of these statuses are consisting of waist circumference, body mass index, and waist to hip ratio that is important as the indicator of body fatness in the adult. However, the index of using waist circumference, body mass index and waist to hip ratio are varied among the ethnicity as shown in Table 1. BMI is calculated as weight in kilograms divided by height in meters squared (kg/m2) [47]. Body mass index reflects body fatness in the majority of the adult population [48]. As recommended by WHO, BMI 18.5–22.9 kg/m² is normal for Asian people [47]. While the waist-to hip ratio (WHR) is calculated as the circumference of the waist divided by that of the hips and used to define central obesity. Healthy WHR is < 0.85 for female and < 0.9 for male [49].

Table 1: Classification of BMI by WHO and of WC by IDF

Classification	world wild range [39-41]	Asian range [39, 40]
BMI		
Underweight	<18.5 kg/m^2	< 18.0 kg/m^2
Normal weight; (healthy BMI)	18.50-24.99 kg/m^2	18.0-22.9 kg/m^2
Over weight	25.00-29.99 kg/m^2	23.00-24.9 kg/m^2
Obesity	30.00-39.9 kg/m^2	≥ 25 kg/m^2
WC and WHR		
healthy WC limits	88 cm for female 102 cm for male	80 cm for female 90 cm for male
Waist-to-hip ratio	≥0.85 for female ≥0.9 for male	

WC; waist circumference, BMI; body mass index, WHR; Waist-to-hip ratio

The visceral fat region (central obesity) is likely to produce certain diabetogenic substances and it is related to the onset of type 2 diabetes and IFG than overall obesity per se [42]. Therefore, several indicators such as BMI, WC, and WHR should be considered as well-known indicators of adiposity in assessing visceral fat. [43]. The optimal adiposity index has been identified by measuring BMI, WC, and WHR in order to indicate individuals with undiagnosed type 2diabetes and pre-diabetes or IFG in Chinese adults. A study by Xu et al. reported that IFG was found among 536 (7.1%) of total 7,567 subjects, type 2 diabetes were diagnosed in 690 (9.1%), and 290 (3.8%) individuals with undiagnosed diabetes. A multinomial logistic regression analysis showed that all of the parameters were significantly associated with IFG, undiagnosed and diagnosed type 2diabetes. As evidenced by higher odds ratios of WC for both undiagnosed and IFG compared to those of WHR and BMI in female subgroup after adjustment for other risk factors, including age, sex, smoking,

physical inactivity, hypertension, and family history of diabetes, among all participants, the association was stronger between undiagnosed Type 2 diabetes and IFG with WC rather than the association with BMI or WHR after adjustment [43].

2.6.5. Hypertension

Hypertension is defined by the highest level of blood pressure, systolic blood pressure (SBP) values more than and equivalence 140 mmHg or diastolic blood pressure value more than and equivalence 90 mmHg and it is explained as a continuous relationship between blood pressure and both cardiovascular and renal events making the difference between normotensive and hypertension were difficult when based on cutoff blood pressure value. In the general population, systolic blood pressure and diastolic blood pressure value have a unimodal distribution [44]. High BP is a widely found as characteristic of both type 1 and type 2 diabetes and unidentified hypertension is frequently occur among the population, therefore diagnostic procedure for the normotensive person with diabetes should be monitored in the routine check by 24-h ambulatory BP [45].

According to the 2003 and 2007 ESH/ESC guidelines, blood pressure was classified in certain different level as mentioned in Table 2 below. [44].

Table 2: 2003 and 2007 ESH/ESC recommend for classification of hypertension

Classification	**Systolic (mmHg)**		**Diastolic (mmHg)**
Optimal	<120	and	<80
Normal	120 – 129	and/or	80 -84
High normal	130 – 139	and/or	85 -89
Grade 1 hypertension	140 -159	and/or	90 -99
Grade 2 hypertension	160 - 179	and/or	100 -1-9

Grade 3 hypertension	≥ 180	and/or	≥ 110
Isolated systolic hypertension	≥140	and	< 90

Obesity, impaired glucose tolerance, and type 2 diabetes are linked with a considerably augmented the hypertension prevalence, cardiovascular, and chronic renal disease. Hypertension is more familiar in diabetic patients than in the general population [46-49]. In the study of cardiovascular disease cases, baseline measurements to estimate the incidence of hypertension were known to be independently associated with elevations in both baseline systolic blood pressure and left ventricular mass, measurement of waist circumference and diabetes mellitus state [47]. In addition, a study on effects of parental hypertension on longitudinal trends in blood pressure with 5198 subjects showed that parental hypertension has an age-independent impact on both male and female descendant in elevations in blood pressure, plasma glucose, and triglyceride levels [50].

2.6.6. Physical inactivity

According to the American Diabetes Association (ADA) 2013 [12], the recommendation for Physical activity in adults who living with diabetes is to perform moderate-intensity aerobic physical activity at least 150 min/week (50-70% of maximum heart rate), with at least spare for 3 days a week with no more than two consecutive days abstinence of exercise. In the absence of contraindications, adults with type 2diabetes should be encouraged to perform resistance training at least twice per week.

The obesity and low level of physical activity are the most important modifiable risk factors for developing type 2 diabetes [51-57]. A previous case-cohort study [58]

reported that in consist of 11,669 male and 15,695 female of whom 5,660 and 5,570 respectively, were having type 2 diabetes incident. Based on sub-cohort data, 6.3% male and 3.9% female developed type 2 diabetes over a median of follow-up time during 12.3 years. The lower levels of LTPA (leisure time for physical activity) increased the risk of incident type 2 diabetes in similar models. The physical activity lower levels were associated with an increased risk of type 2 diabetes across all strata of body mass index. The physical activity higher level was associated with lower risk of type 2 diabetes independently of obesity as evidenced by previous observational studies [53, 54, 56]. Reductions the developing type 2 diabetes risk were seen independently of general adiposity in male and abdominal adiposity in the female. Evidence suggested that physical activity might have a protective effect in normal weight, overweight, and obese individual (except for obese female), and in lean and abdominally obese male and female. The protective effects were appeared to be more pronounced in abdominally obese male and female [58].

2.6.7. Dyslipidemia or lipid profile

American Diabetes Association 2013 recommendation [12] for screening dyslipidemia target is carried out in adult with low risk of any lipid values, including low density lipoprotein cholesterol less than 100 mg/dl, high density lipoprotein cholesterol more than 50 mg/dl, and triglycerides less than 150 mg/dl, lipid values should be assessed in a repeated-measurement in every 2 years. In most adult patients with diabetes, it is necessary to measure fasting lipid profile at least annually. Lipid risk factors including total cholesterol (TC), LDL-C, HDL-C, and TG in abnormality values are modifiable risk factors in the onset of type 2 diabetes. One of Italian longitudinal study [59] aims to estimate the association among plasma lipids,

lipoproteins, other metabolic risk factors in three groups, and their role in predicting total fatal events (follow-up in normal fasting glucose), IFG, and type 2 diabetes subjects). As the result, two of lipid risk factors (TC and HDL-C) were evaluated. For NFG and IFG male, and for both type 2 diabetes male and female, the "HDL-C" was considered as a significant protective factor for total deaths (NFG male: HR = 0.79, 95% CI 0.67-0.93; IFG male: HR = 0.59, 95% CI 0.45-0.79; type 2 diabetes male: HR = 0.55, 95% CI 0.34-0.89; type 2diabetes female: HR = 0.61, 95% CI 0.44-0.86). This study confirmed that a factor including low Apo A-1 and the low HDL-C" were risk factors for all-cause mortality in older male, independently of the glycaemia level, and in the female with type 2 diabetes. In males, HDL-C concentrations decrease during puberty and early adulthood and thereafter remain lower than those in the female. This trend could explain why the low HDL-C level is a risk factor for mortality in male, independently from other risk factors [60].

2.6.8. Current smoking

Smoking is one of the main preventable cause of morbidity and mortality. Smoking is a great independent risk factor for microvascular disease and improves the cardiovascular events and diabetes-related mortality. In addition, smoking is a risk factor for developing type 2 diabetes, it is associated with poorer glycemic control, any other disease-related complications, and various predispose to microvascular events [61]. In the prospective cohort study of middle-aged male and female, cigarette smoking was given a greater cumulative exposure in the prediction of diabetes incident for 9 years follow-up in 1254 adults. However, smoking cessation did not seem to reduce the risk of type 2 diabetes due to potentially mediated by weight gain and systemic inflammation factors of those quitters. Quitters may expose at higher

risk for diabetes before quitting because of potentially a wide range of established diabetes risk factors, including age, BMI, physical inactivity, and lipids [62].

2.6.9. Gestational diabetes and/or History of having baby weighing more than 4 kg

Two large current meta-analyses of the relations between the risk of type 2 diabetes and birth weight in female who are non-pregnancies populations produced an inconsistent result. Fourteen observational studies of a meta-analysis, Harder et al.[63] formed a U-shaped association, although Whincup et al. [64], when studying thirty-one studies reported, created a typical opposite relation between diabetes risk and birth weight. In a great study, the risk of type 2diabetes was proposed a reverse J shape from the Nurses' Health Study [65]. Evidence recommends that the descendants of maternal diabetes are at higher risk for diabetes, the influence of maternal diabetes have been probably an effect stemming [66-68]. Because gestational diabetes mellitus is frequently complex with macrosomia [65], an association between risk of diabetes and high birth weight can be predicted diabetes. Somewhat seems to reflect the overall high genetic predisposition in this ethnic group to develop early insulin resistance [69].

2.7. Diabetes risk score

The diabetes risk score has been designed as a screening tool (developed questionnaire) for characterizing high-risk subjects in the population according to their future risk of the onset of type 2diabetes and for increasing consciousness on the modifiable risk factors and healthy lifestyle [70-72]. As we recognized that 30 to 60% of people with diabetes in the community is undiagnosed [70, 71] and that undiagnosed diabetes is associated with increased risk of cardiovascular disease and

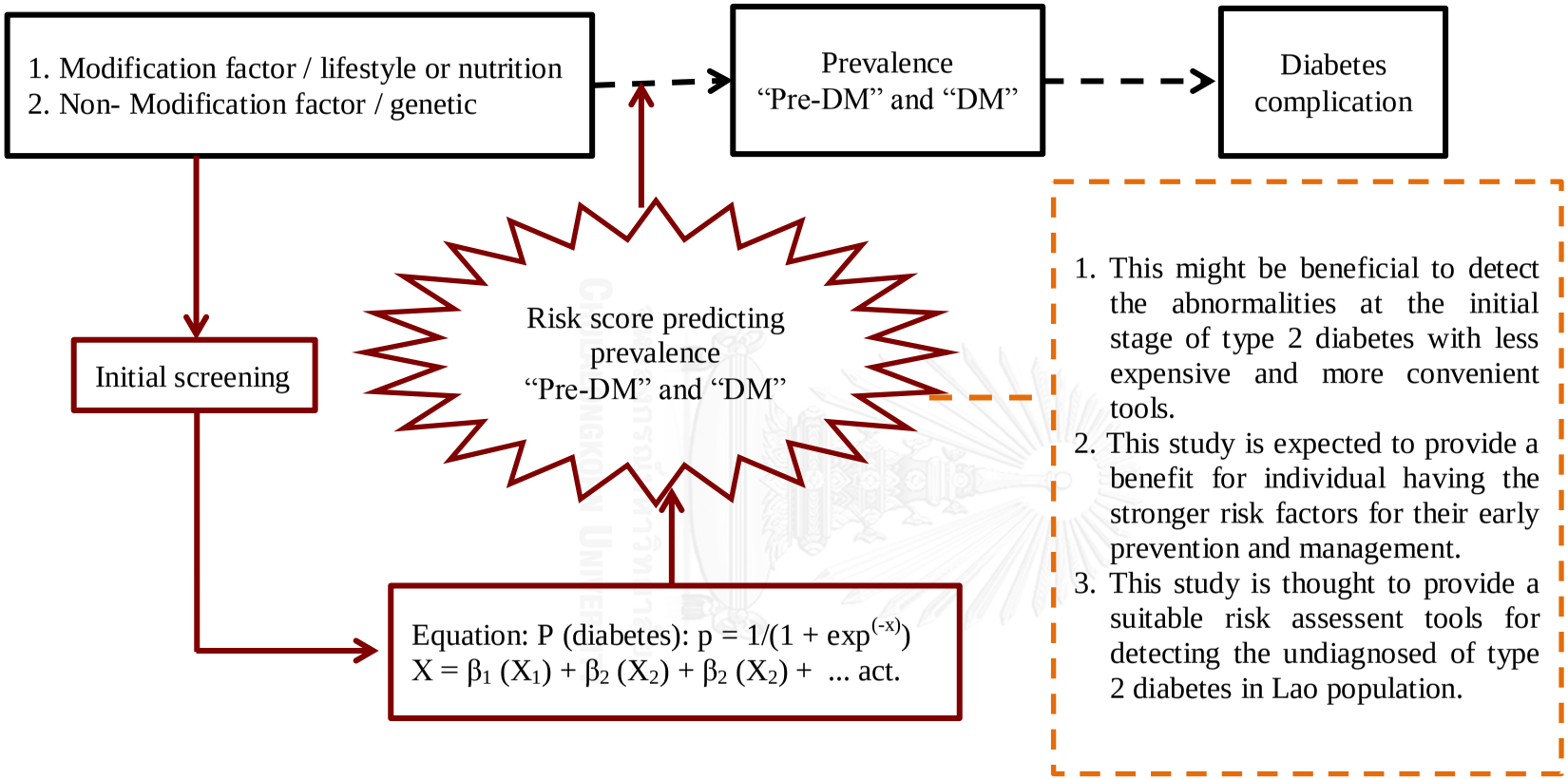
mortality. Moreover, many individuals with a high diabetes risk score may have asymptomatic, unrecognized diabetes and therefore may require blood glucose testing for diagnosis, other clinical assessments and therapy [73, 74]. Mortality risk is increased in the large group of people who have positive risk scores, justifying direct action in this group [75].

The risk score is one of a number of scoring systems used to determine an individual's probabilities of having diabetes. It is used for a primary medical care setting [76, 77]. The high-risk people identified will benefit from obtaining health education and having the opportunity to engage in healthy lifestyles at an early stage so as to prevent or delay the onset of type 2 diabetes. Diabetes prevention trials have been mostly based on individuals with high-risk status defined by blood tests [77, 78]. However, non-invasive risk scores could be used as part of the public health approach to diabetes prevention to identify individuals who should receive biochemical testing [75] which is one biochemical testing probably more accurate than non-invasive risk models [79].

Several models were developed and applied to specific populations. Previous studies reported that many factors may influence the reduction of performance of diabetes risk prediction. This is mostly because of the difference in the characteristics of the populations (ethnicity, the group of age, and gender), the method of conducted studies and the strength of associations between risk factors [80]. Therefore, good ways of identifying diabetes risk models for a given population are frequently selected by identical or similar ethnicity [80, 81]. Similar to other study showed that the decision to use a particular model could be country specific and depends on factors other than model performance, such as availability of measurements in the setting

where the model is used [76]. In general, a noninvasive risk score model may represent a valid simple, safe, low-cost initial screening tool for the identification of individuals with unknown diabetes or glucose intolerance and the testing will drastically decrease the number of invasive glucose test is necessary at the screening phase as ever been studied in Thai populations [72-74].

Figure 1: Conceptual Frameworks



"DM" = type 2 diabetes

"Pre-DM = pre-diabetes

→ = progress

→ = screening to detect pre-diabetes and undiagnosed diabetes by risk score

⬚ = benefits of risk score

Chapter III
Methodology

3.1. Study design

The study was designed as a cross-sectional investigation, carried out in 15 selected villages of 2 districts of Vientiane municipality, Lao PDR; it began from December 2015 to July 2017.

3.1.1. Population and Study Participants

The target population in this study was individuals living in the selected community. All participants went through the screening process for their eligibility. The criterion for inclusion was the age range between 30 to 70 years and exclusion criteria were anyone diagnosed with diabetes and/or using any anti-diabetic drug.

3.1.2. Determination of number of study sample size

The appropriate sample size was derived from the results of the previous study with quite similar ethical population of which the prevalence of diabetes was 7.4% and had 4 variables as significant factors [35] and a rule of thumb is that models should be developed with 10 to 20 events per variable (EPV) [82, 83]. So an adequate sample size needed to estimate the population prevalence with a good precision can be calculated according to the following:

Sample size is needed to precision = 20 (EPV) x 4 variance = 80 sample size.

$$\text{sample size is needed to estimate the population; } \mathrm{N} = \frac{100(\%) \times 80}{7.4\ (\%)} = 1{,}082$$

N = 1,082 participants

According to the calculation above, the required sample size for this study is 1,082 participants. The study was approved by the National Institute of Public Health National Ethics Committee for Health Research (NECHR), Lao People's Democratic Republic and each participant signed informed consent before enrolling into the study.

3.1.3. The study protocol

This study comprised of 2 phases including screening process and risk assessment.

Phase I: Screening process was initiated by the interview on demographic information with each participant at subjects' local area for 10-15 minutes. Then they were appointed to do physical exam including the anthropometry and blood pressure measurement for about 10-15 minutes following by antecubital vein blood sample collection in the morning at 6:30 – 9:00 am after underwent the overnight fast for about 8-10 hours in the day before.

Phase-II: Prevalence and risk assessment. Firstly a detection of pre-diabetes and diabetes prevalence was firstly identified by the FPG level 100-125 mg/dl for pre-diabetes and equivalent to or more than 126 mg/dl for diabetes; then a repeated-testing was carried out in order to affirm the presence of undiagnosed type 2diabetes. Secondly, in the risk assessment, all participants were randomly divided into 2 subgroups for developing and validating risk score [84] as the first one required ¾ of

all participants in developing the pre-diabetes and diabetes risk scores. And, the second one was ¼ of all participants for validating of the risk scores.

3.2. Materials and methods

Characteristics of participants are including demographic data, anthropometry, blood pressure, and blood glucose test as following below:

Demographic data are including age, gender, history family diabetes include parents and sibling, female with history of having baby weighing more than 4 kg, gestational diabetes, and history or current present of dyslipidemia (triglycerides >150 mg/dl, LDL-C ≥ 100 mg/dl, HDL-c < 35 mg/dl), smoking habit, physical inactivity (less than 150 min/week or 3 day/week).

The anthropometric measurement was recorded from each participant. Body mass index was calculated from body weight (kg) divided by body height (m^2) using the weight and height scale with the precision of nearest 0.1kg and 0.1 cm, respectively. The criteria for Asian people recommended by WHO as normal, overweight and obesity BMI are 18.5-22.9 kg/m^2, 23.00-24.9 kg/m^2 and more than and equivalence 25 kg/m^2, respectively [40, 85]. Waist circumference was measured with standing to relax and underclothes subject at the midpoint between the anterior superior iliac crest and the lowest rib using measuring tape [36]. According to the criteria for Asian people recommended by IDF, the healthy WC is < 80 cm for female and < 90 cm for male. Weight-hip ratio (WHR) is calculated as WC (cm) divided by hip circumference (cm). Hip circumference is measured at the level of maximal gluteal protrusion [86] for Healthy WHR is < 0.85 for female and < 0.9 for male [41].

The blood pressure (BP) is measured after 5 minutes relaxing. The participants were invited to sit up right with their upper arm positioned at heart level and measured by Omron blood pressure monitor. The value of blood pressure is determined according to the guidelines of the European Society of BP (ESH) and of the European Society of Cardiology (ESC) 2013 [44].

Fasting Plasma Glucose (FPG) was utilized in the present study to diagnose type 2 diabetic patients. The term "elevated plasma glucose" is used to define an individual who has either pre-diabetes or undiagnosed type 2diabetes by following ADA standard. The level of plasma glucose gained from FPG defined the prevalence of pre-diabetes and undiagnosed type 2diabetes. In FPG, the glucose level < 100 mg/dl, 100–125 mg/dl, ≥ 126 mg/dl indicates normal, pre-diabetes and undiagnosed type 2diabetes respectively. In another word, undiagnosed type 2diabetes is defined as the presence of actual type 2diabetes [13]. Venous blood samples were collected 5 ml from the antecubital vein into the test tube and stored in the -20^0C [13]. The blood glucose level was analyzed by a glucose oxidase method in the laboratory of Vientiane Mahosot Hospital using automatic analyzer Huma Star 600-Human.

3.3. Development of risk score

In the risk score development, 75% in each sub-group of the participants (normal, pre-diabetes, and type 2 diabetes subgroups) were randomly selected and utilized. The examination of factors associated with pre-diabetes and type 2 diabetes prevalence was then conducted separately. Initially, the bivariate association between each potential risk factor and the outcome was determined by using the odds ratio (OR) as the measure of the association. Multiple logistic regressions with backward stepwise selection were then utilized in the statistical modeling. Variables associated

with the outcome with p-value < .2 in the bivariate analysis were eligible for addition to the modeling procedures, and p-value of < .05 was the cut-off for the statistically significant level. The diabetes risk scores value was derived from the β-coefficient and by multiplying its β-coefficient in the regression model by 10 for simplified equation [87, 88] to the original equation $\beta_1 (x_1) + \beta_2 (x_2) + \beta_3 (x_3) + \beta_4 (x_4) +$…act. While, the probability value of having diabetes used this equation: $p = 1/ (1 + \exp (-x))$ [89-91]. Lastly, a generate risk scores model was applied to determine the appropriate cut off value of risk equation by using a receiver operating characteristic (ROC) analysis.

Concerning the pre-diabetes outcome, two prediction models were developed: the first model relied on the multivariate analysis result specifically for the pre-diabetes prevalence; while the second model was shared with the prediction model for type 2 diabetes described in the previous paragraph.

3.4. Validating of the risk score

The remaining 25% of the participants in each sub-group (normal, pre-diabetes, and type 2 diabetes) were utilized in the risk score validation. The performance of risk scores was verified by ROC curve analysis. The accuracy of the prediction of pre-diabetes and diabetes was showed by AUC. The cutoff point of the risk score, sensitivity, and specificity, positive were investigated. The positive predictive value (PPV) is the probability that an individual with a positive screening result has the disease which calculates by (sensitivity × specificity) / [sensitivity × prevalence + (1- specificity) × (1- prevalence)] [92, 93]

3.5. Statistical analysis

Baseline characteristic was analyzed to recognize the variation of the diabetes risk categories. The baseline characteristic was presented as descriptive statistic crosstabs with chi-square to distinguish the differences among the participant sub-groups (normal or without diabetes, pre-diabetes and undiagnosed diabetes). Probability (p value) less than .05 is considered as statistically significant.

3.6. Benefit of study

Although many diabetes risk scores existed, this may not be readily applicable for Lao population since a lot of evidence indicated that the risk scores developed for one population had lower validity when they were applied to another population. As the development of our diabetes and pre-diabetes risk scores was based on a group Vientiane population, they will be more applicable for Lao population than the existing risk scores. This might be beneficial to detect the abnormalities at the initial stage of type 2 diabetes for early prevention and management with less expensive and more convenient tools.

There were several previous studies aimed to see the effect of screening of pre-diabetes and diabetes prevalence. This might be beneficial to detect the abnormalities at the initial stage of type 2 diabetes with less expensive and more convenient tools. In addition, this study is expected to provide a benefit for the individual having the stronger risk factors for their early prevention and management. Furthermore, this study is thought to provide a suitable risk assessment tools for detecting the undiagnosed of type 2 diabetes in Lao population.

3.7. Schedule of work

Table 3 Schedule of work of study

	Months																	Location
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	
Literature review																		BKK
Writing proposal																		BKK
Proposal defense																		BKK
Ethical review																		VTE
Course work																		BKK
Survey location and Contact with sanitation																		**VTE**
Subjects recruitment																		**VTE**
Data collection																		**VTE**
Data Analysis, Results and discussion																		**BKK**
Conclusion																		**BKK**
Submission for thesis defense																		**BKK**
Thesis defense																		**BKK**

Chapter IV
Results

4.1. The characteristic of all participants

Initially, 1338 subjects from 15 villages of 2 districts of Vientiane municipality were interested in the study. However, 240 of them were excluded from the study due to technical or personal reasons, leaving the 1,098 subjects finally participated in the FPG test (Figure 2). The basic characteristic of the participants was shown in Table 4. There were more females (74.9%) than males (25.1%). The majority of them are in 30-59 years age-group. Approximately 24.8% had family history of diabetes. Among female participants, 0.5% and 2.0% previously had gestational diabetes and history of delivering infant with >4 kg birth weight respectively. Prevalence of hypertension and history of currently taking antihypertensive drug(s) were 37.2% and 20.1% respectively, while the prevalence of dyslipidemia and history of currently taking lipid-lowering drugs were 10.7% and 8.7%. Concerning the health behaviors, 11% smoke cigarette and 84.9% were physically inactive. The proportions of those with high waist circumference, body mass index, and waist to hip ratio were 50.5 %, 59.9 %, and 72.5 % respectively. About 26.5% and 31.4% had high systolic and diastolic blood pressures respectively.

Figure 2: flow diagram of selected subjects for the study

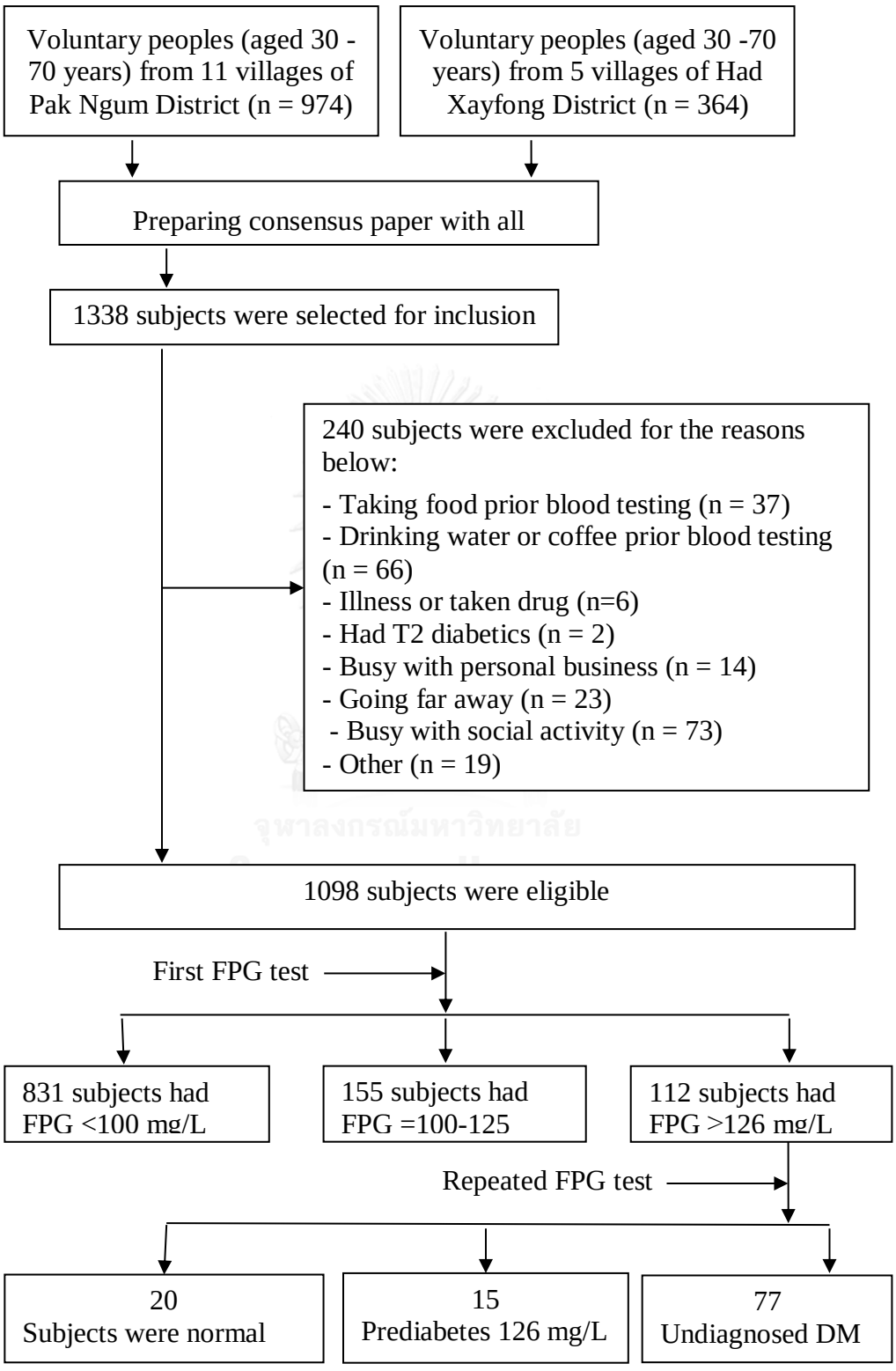


Table 4: Demographics, behavioral, physiological and metabolic characteristics of the participants (n = 1098)

Characteristic		**Female (823)** *No (%)*	**Male (275)** *No (%)*	**Total (1098)** *No (%)*
Age	30-39	210 (19.1)	58 (5.3)	268 (24.4)
	40-49	270 (24.6)	93 (8.5)	363 (33.1)
	50-59	201 (18.3)	71 (6.5)	272 (24.8)
	60-70	141 (12.8)	54 (4.9)	195 (17.8)
Age ≥ 40 yeas	No	210 (19.1)	58 (5.3)	268 (24.4)
	Yes	612 (55.7)	218 (19.9)	830 (75.6)
Family history of diabetes.	No	628 (57.2)	198 (18.0)	826 (75.2)
	Yes	194 (17.7)	78 (7.1)	272 (24.8)
Antihypertensive drug[a].	No	648 (59.0)	229 (20.9)	877 (79.9)
	Yes	174 (15.8)	47 (4.3)	221 (20.1)
Physical inactivity[b]	No	106 (9.7)	60 (5.5)	166 (15.1)
	Yes	716 (65.2)	216 (19.7)	932 (84.9)
smoking	No	809 (73.7)	168 (15.3)	977 (89.0)
	Yes	13 (1.2)	108 (9.8)	121 (11.0)
History of hyperdyslipidemia	No	121 (11.0)	40 (3.6)	161 (14.7)
	Yes	89 (8.1)	29 (2.6)	118 (10.7)
	Never	612 (55.7)	207 (18.9)	819 (74.6)
Intake dyslipidemia drug.	No	746 (67.9)	256 (23.3)	1002 (91.3)
	Yes	76 (6.9)	20 (1.8)	96 (8.7)

Characteristic		Female (823) *No (%)*	Male (275) *No (%)*	Total (1098) *No (%)*
Gestational diabetes	No	796 (72.5)	0 (.0)	796 (72.5)
	Yes	6 (.5)	0 (.0)	6 (.5)
	Never	20 (1.8)	0 (.0)	20 (1.8)
HDBW >4kg	No	780 (71.0)	0 (.0)	780 (71.0)
	Yes	22 (2.0)	0 (.0)	22 (2.0)
	Never	20 (1.8)	0 (.0)	20 (1.8)
BMI ≥ 25 kg/m^2	No	391 (35.6)	152 (13.8)	543 (49.5)
	Yes	431 (39.3)	124 (11.3)	555 (50.5)
WC (cm) F: ≥ 80, M: ≥ 90	No	261 (23.8)	179 (16.3)	440 (40.1)
	Yes	561 (51.1)	97 (8.8)	658 (59.9)
WHR; F: ≥0.85, M: ≥0.9	No	195 (17.8)	107 (9.7)	302 (27.5)
	Yes	627 (57.1)	169 (15.4)	796 (72.5)
SBP ≥ 140 mmHg	No	603 (54.9)	204 (18.6)	807 (73.5)
	Yes	219 (19.9)	72 (6.6)	291 (26.5)
DBP ≥ 90 mmHg	No	579 (52.7)	174 (15.8)	753 (68.6)
	Yes	243 (22.1)	102 (9.3)	345 (31.4)
Hypertension	No	528 (48.1)	161 (14.7)	689 (62.8)
	Yes	294 (26.8)	115 (10.5)	409 (37.2)
FPG	normal	640 (58.3)	211 (19.2)	851 (77.5)
	prediabetes	123 (11.3)	47 (4.3)	170 (15.5)
	undiagnosed	59 (5.4)	18 (1.6)	77 (7.0)

a (use medication to treat hypertension). b (< 150 min/week or 3 day/week). The body mass index; BMI. The waist circumference; WC. The waist to hip ration; WHR. The systolic blood pressure; SBP. The diastolic blood pressure; DBP. The fasting plasma glucose; FPG. Hypertension (SBP ≥ 140 or DBP ≥ 90 mmHg); Hypertension, History deriver a baby weighing > 4 kg; HDBW >4kg.

4.2. The prevalence of diabetes and pre-diabetes

Of all 1,098 participants, 77 had FPG ≥ 126 mg/dl while 170 had FPG of 100 to 125 mg/dl, the overall prevalence of undiagnosed diabetes and pre-diabetes were 7.0% and 15.5% respectively (Table 4). The diabetes prevalence and pre-diabetes according to the participants' characteristics were shown in Table 5. Prevalence of diabetes and pre-diabetes were homogeneous among sex, female previously had gestational diabetes and history of delivering infant with >4 kg birth weight, dyslipidemia and history of currently taking lipid-lowering drugs, smoke cigarette, physically inactive They were, however, quite varied according to age, history of currently taking antihypertensive drug(s), high BMI, high WC, high WHR, hypertension, and family history of diabetes (only for type 2 diabetes.

Table 5: Undiagnosed diabetes and pre-diabetes prevalence according to the personal characteristics

Table 5: prevalence of undiagnosed diabetes and pre-diabetes according to the personal characteristics

characteristics	**N**	**diabetes**			**Pre-diabetes**		
		n	**%**	***p-value***	**n**	**%**	***p-value***
Age				*0.004*			*0.001*
(30-39)	268	6	2.2		25	9.3	
(40-49)	363	34	9.4		52	14.3	
(50-59)	272	23	8.5		60	22.1	
(60-70)	195	14	7.2		33	16.9	
Age category				*0.0001*			*0.001*
< 40	268	6	2.2		25	9.3	
≥ 40	830	71	8.6		145	17.5	
Sex				*0.712*			
female	822	59	7.2		123	15	
male	276	18	6.5		47	17	
Family history of diabetes.				*0.007*			*0.127*
No	826	48	5.8		120	14.5	
Yes	272	29	10.7		50	18.4	
Antihypertensive drug[a].				*0.012*			*0.014*
No	877	53	6		124	14.1	
Yes	221	24	10.9		46	20.8	

Table 5: prevalence of undiagnosed diabetes and pre-diabetes according to the personal characteristics

characteristics	N	diabetes			Pre-diabetes		
		n	**%**	***p-value***	**n**	**%**	***p-value***
Physical inactivity[b]				*0.906*			*0.945*
No	166	12	7.2		26	15.7	
Yes	932	65	7		144	15.5	
smoking				*0.855*			*0.944*
No	977	69	7.1		151	15.5	
Yes	121	8	6.6		19	15.7	
History of dyslipidemia				*0.194*			*0.154*
No	161	11	6.8		21	13	
Yes	118	13	11		25	21.2	
Never	819	53	6.5		124	15.1	
Intake dyslipidemia drug.				*0.309*			*0.222*
No	1002	65	6.5		151	15.1	
Yes	96	12	12.5		19	19.8	
Gestational diabetes				*0.836*			*0.348*
No	796	57	7.2		122	15.3	
Yes	6	0	0		0	0	
Never	20	2	10		1	5	
History deriver a baby weighing > 4 kg				*0.207*			*0.192*
No	780	53	6.8		116	14.9	
Yes	22	4	18.2		6	27.3	
Never	21	2	10		1	5	

Table 5: prevalence of undiagnosed diabetes and pre-diabetes according to the personal characteristics

characteristics	N	Diabetes			pre-diabetes		
		n	**%**	***p-value***	**n**	**%**	***p-value***
BMI ≥ 25 kg/m^2				*0.032*			*0.0001*
No	543	29	5.3		59	10.9	
Yes	555	48	8.6		111	20	
WC (cm) F: ≥ 80, M: ≥ 90				*0.0001*			*0.002*
No	440	13	3		50	11.4	
Yes	658	64	9.7		120	18.2	
WHR; F: ≥0.85, M: ≥0.9				*0.015*			*0.028*
No	302	12	4		35	11.6	
Yes	796	65	8.2		135	17	
Hypertension				*0.0001*			*0.001*
No	689	28	4.1		88	12.8	
Yes	409	49	12		82	20	

a (use medication to treat hypertension). b (< 150 min/week or 3 day/week).

Body mass index; BMI. Waist circumference; WC. Waist-to hip ratio; WHR. Hypertension; SBP ≥ 140 or DBP ≥ 90mmHg.

4.3. Developing diabetes and pre-diabetes risk scores

Totally 823 participants (75% of all participants) were utilized in the risk score model development, including 642 normal, 128 pre-diabetes, and 53 diabetes subjects. The crude odds ratio (OR) of undiagnosed diabetes according to the participants' characteristics were shown in table 6. Among these, nine factors were significantly associated with the diabetes prevalence including hypertension with SBP ≥ 140 or DBP ≥ 90 mmHg (OR= 4.145, p = .005), high WC (OR= 5.180, p = .0001), age ≥ 40 (OR= 6.344, p = .002), dyslipidemia drug intake (OR= 2.878, p = .006), high WHR; F: ≥ 0.85, M: ≥ 0.9 (OR= 3.442, p= .010), BMI; ≥ 25 kg/m^2 (OR= 2.414, p= .004), history of dyslipidemia (OR= 2.767, p= .007), family history of diabetes (OR=2.096, p= .013), and currently taking antihypertensive drug (OR=1.982, p= .031). Concerning the pre-diabetes outcome, there were seven factors significantly associated with its prevalence including age ≥ 40 (OR 1.738, p= .025), Antihypertensive drug use (OR 1.528, p= .064), had history delivery birth weight ≥ 4 kg (OR 2.339, p= .147), BMI ≥ 25 kg/m^2 (OR 1.107, p= .0001), high WC [(F: ≥ 80, M: ≥ 90 cm) (OR 1.045, p= .0001)], high WHR [(F: ≥ 0.85, M: ≥ 0.9) (OR 2.095, p= .001)], and having hypertension (OR 1.045, p= .0001) [SBP ≥ 140 mmHg; (OR 1.011, p= .007) and/or DBP ≥ 90 mmHg; (OR 1.026, p=.001)] However, further multivariate analyses to determine the un-confounded factor-outcome association showed that only as hypertension with SBP ≥ 140 or DBP ≥ 90 mmHg (OR= 3.085, p= .0003); waist circumference with F: ≥ 80, M: ≥ 90 cm (OR= 4.127, p= .001); Age ≥ 40 (OR= 5.545, p= .005); and family history of diabetes included in the final model (OR= 2.079, p= .020) and independently associated with undiagnosed diabetes prevalence, while age ≥ 40 [ORs 1.684 (1.026 ± 2.764), p= .039], having hypertension [OR 1.605 (1.076 ±

2.395), p= .020], and BMI $\geq$ 25 kg/m^2 [OR 1.097 (1.048 ± 1.148), p= .0001] were significantly and independently associated with pre-diabetes prevalence (Table 7).

Table 6: Unadjusted odds ratio (OR) of having undiagnosed diabetes and pre-diabetes according to the personal characteristics

Characteristics	diabetes				Pre-diabetes			
	OR	95% C.I.		*p-value*	OR	(95% CI)		*p-value*
		Lower	Upper			Lower	Upper	
Age real number (per unit increase 1 year)	1.027	1.001	1.053	*0.039*	1.192	0.996	1.426	*0.055*
Age category								
30-39	1				1			
40-49	0.202	0.054	0.748	*0.017*	0.736	0.39	1.39	*0.345*
50-59	1.296	0.593	2.83	*0.515*	1.038	0.58	1.856	*0.9*
60-70	1.488	0.662	3.345	*0.337*	1.85	1.047	3.267	*0.034*
age ≥ 40								
No	1				1			
Yes	6.344	1.954	20.601	*0.002*	1.738	1.072	2.818	*0.025*
Sex (male is reference)								
No	1				1			
Yes	1.081	0.572	2.043	*0.809*	1.272	0.836	1.934	*0.261*
Family history of diabetes.								
No	1				1			
Yes	2.096	1.167	3.764	*0.013*	1.251	0.811	1.93	*0.312*
Antihypertensive drug intake[a].								
No	1				1			
Yes	1.982	1.066	3.684	*0.031*	1.528	0.976	2.391	*0.064*

Table 6: Unadjusted odds ratio (OR) of having undiagnosed diabetes and pre-diabetes according to the personal characteristics

Characteristics	diabetes				Pre-diabetes			
	OR	95% C.I.		*p-value*	OR	(95% CI)		*p-value*
		Lower	Upper			Lower	Upper	
Physical inactivity[b]								
No	1				1			
Yes	1.195	0.496	2.881	*0.691*	0.735	0.44	1.228	*0.24*
Smoking								
No	1				1			
Yes	1.186	0.516	2.725	*0.687*	1.035	0.573	1.869	*0.91*
History of dyslipidemia								
No	1				1			
Yes	1.374	0.656	2.881	*0.4*	0.733	0.415	1.295	*0.285*
Never test	2.767	1.325	5.78	*0.007*	1.342	0.741	2.431	*0.332*
Intake dyslipidemia lowering drug								
No	1				1			
Yes	2.878	1.362	6.082	*0.006*	1.055	0.681	1.633	*0.811*
Gestational diabetes								
No	1				1			
Yes	0.907	0.478	1.722	*0.766*	0.804	0.528	1.224	*0.309*

Table 6: Unadjusted odds ratio (OR) of having undiagnosed diabetes and pre-diabetes according to the personal characteristics

Characteristics	diabetes				Pre-diabetes			
	OR	95% C.I.		*p-value*	OR	(95% CI)		*p-value*
		Lower	Upper			Lower	Upper	
HDBW ≥ 4 kg								
No	1				1			
Yes	0.866	0.454	1.651	*0.662*	0.766	0.501	1.169	*0.216*
Never	2.54	0.499	12.919	*0.261*	2.339	0.741	7.38	*0.147*
BMI real number (per unit increase kg/m^2)	1.122	1.055	1.193	*0.0001*	1.272	0.836	1.934	*0.261*
BMI ≥ 25 kg/m^2								
No	1				1			
Yes	2.414	1.329	4.387	*0.004*	1.107	1.059	1.158	*0.0001*
WC real number (per unit increase cm)	1.058	1.03	1.086	*0.0001*	0	0	.	*0.999*
WC (cm) F: ≥ 80, M: ≥ 90								
No	1				1			
Yes	5.18	2.304	11.648	*0.0001*	1.045	1.025	1.065	*0.0001*
WHR real number (per unit increase)	412.169	8.782	19345.33	*0.002*	87.274	5.174	1472.041	*0.002*
WHR; F: ≥0.85, M: ≥0.9								
No	1				1			
Yes	3.442	1.448	8.185	*0.005*	2.095	1.378	3.184	*0.001*

Table 6: Unadjusted odds ratio (OR) of having undiagnosed diabetes and pre-diabetes according to the personal characteristics

Characteristics	diabetes				Pre-diabetes			
	OR	95% C.I.		*p-value*	OR	(95% CI)		*p-value*
		Lower	Upper			Lower	Upper	
SBP real number (per unit increase mmHg)	1.026	1.015	1.037	*0.0001*	2.006	1.24	3.247	*0.005*
SBP ≥140 mmHg								
No	1				1			
Yes	4.593	2.586	8.156	*0.0001*	1.011	1.003	1.02	*0.007*
DBP real number (per unit increase mmHg)	1.056	1.035	1.077	*0.0001*	1.495	0.541	4.127	*0.438*
DBP ≥ 90 mmHg								
No	1				1			
Yes	4.231	2.374	7.539	*0.0001*	1.026	1.011	1.041	*0.001*
hypertension								
No	1				1			
Yes	4.145	2.293	7.494	*0.0001*	2.003	1.364	2.941	*0.0001*

a (use medication to treat hypertension). b (< 150 min/week or 3 day/week). Body mass index; BMI. Waist circumference; WC. The waist-to hip ratio; WHR. Systolic blood pressure; SBP. Diastolic blood pressure; DBP. Hypertension (SBP ≥ 140 or DBP ≥ 90mmHg); Hypertension, History deriver a baby weighing > 4 kg; HDBW >4kg.

Table 7: Adjusted odds ratio (OR) of having undiagnosed diabetes and pre-diabetes and their scoring algorithms

Characteristics	Type 2 Diabetes						Pre-diabetes					
	Beta-coefficients	OR	95% C.I.		*p-value*	Score	Beta-coefficients	OR	95% C.I.		*p-value*	Score
			Lower	Upper					Lower	Upper		
FDM	0.7	2.10	1.12	3.858	*.02*	7	-	-	-	-	-	-
WC	1.4	4.13	1.81	9.412	*.001*	14	-	-	-	-	-	-
HTN	1.1	3.08	1.678	5.67	*.0003*	11	0.473	1.61	1.076	2.395	*.02*	5
Age ≥ 40	1.7	5.55	1.672	18.387	*.005*	17	0.521	1.68	1.026	2.764	*.039*	5
BMI	-	-	-	-	-	-	0.092	1.10	1.048	1.148	*.0001*	1
Total						49						11

Family history of diabetes; FDM. Body mass index ≥ 25 kg/m^2; BMI. Waist circumference; WC. Systolic blood pressure; SBP.

Diastolic blood pressure; DBP. Hypertension (SBP ≥ 140 or DBP ≥ 90 mmHg); HTN

The Diabetes and pre-diabetes risk score values were derived from the β-coefficient and by multiplying its β-coefficient in the regression model by 10 for simplified equation [87, 88]. The equation of the risk factors for type 2 diabetes was 1.7 (age ≥ 40) + 1.4 (WC) + 1.1 (hypertension or HTN) + .7 (family history of diabetes or FDM) (Table 7). The formula could be simplified to 17 (age ≥40) + 14 (WC) + 11 (HTN) + 7 (FDM). The probability values of having diabetes vary from 0 to 49 which are calculated as the sum of the scores of all individual risk factors.

Concerning pre-diabetes, its equation was .521(age ≥ 40) + .473(hypertension) +.092 (BMI). The formula could be simplified to 5 (age ≥ 40) + 5 (HTN) + 1 (BMI). The probability values of having pre-diabetes vary from 0 to 11 which are calculated as the sum of the scores of all individual risk factors.

4.4. Validating of diabetes and pre-diabetes risk scores

4.4.1 Diabetes risk score

The performance of risk scores was examined among the remaining 25% of the participants including 209 normal and 24 diabetes individuals, with the total of 233 participants. The area under the ROC curve (AUC) indicated the accuracy of the prediction of risk scores; AUC = .698 (95% confidence interval .584 - .812, p = .002) as shown in figure 3 (B). The sensitivity decreases as the cut-off point increases, while the specificity was reverse. The cutoff point of risk score was ≥ 29.5, for the sensitivity, specificity and positive predictive value was 0.75, 0.55 and 17.8% respectively (Show in Table 8). Increasing risk score was obviously associated with increasing prevalence of the undiagnosed diabetes (chi-square for linear trend, p < 0.02) (Table 8). The exception was in the individuals with score = 0 - 9 in the risk score validation subgroup, where the prevalence of undiagnosed diabetes was 6.7%

(Table 9). Additional analysis by dichotomizing participants into 2 subgroups basing on the cutoff point of 29.5, the result showed that the percentages of participants in the risk score developing and validating groups having score ≥ 29.5 were 15.2% and 19.1% and those having score < 29.5 were 2.3 % and 5.2 % respectively (Table 10).

Figure 3: the ROC curve analysis of the diabetes risk score among the risk score model development (A) and validation (B) sub-groups

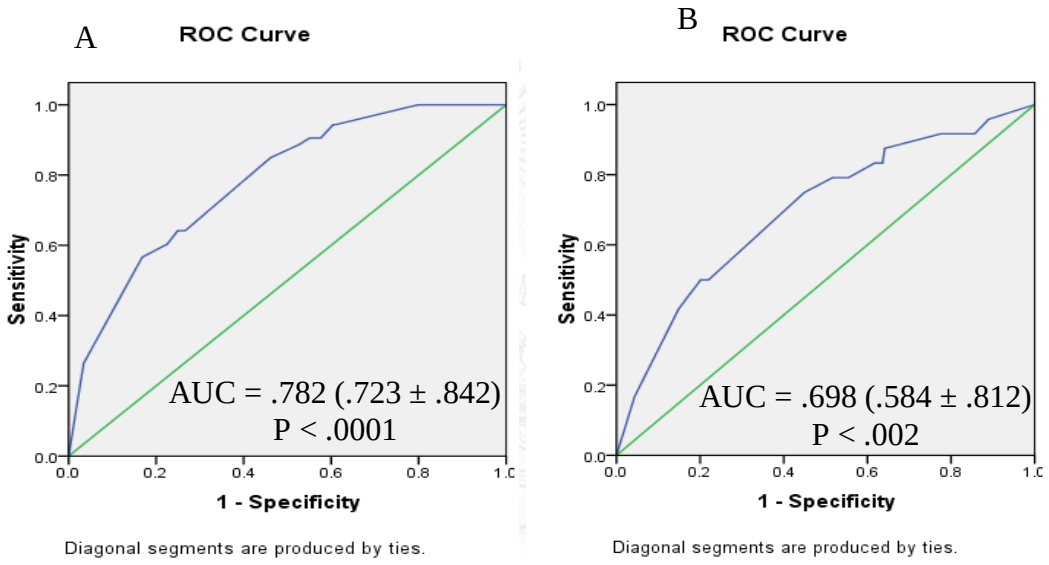


Table 8: The performance of the diabetes risk score at the different cutoff points among the risk score model development and validation sub-groups

Model Development Sub-group			**Model Validation Sub-group**		
risk score	**Sensitivity**	**Specificity**	**risk score**	**Sensitivity**	**Specificity**
-1.0	1	0	-1.0	1	0
3.5	1.000	.083	3.5	.958	.110
9.0	1.000	.117	9.0	.917	.144
12.5	1.000	.132	12.5	.917	.163
15.5	1.000	.201	15.5	.917	.225
17.5	.943	.391	17.5	.875	.359
19.5	.943	.396	19.5	.833	.364
22.5	.906	.424	22.5	.833	.383
24.5	.906	.449	24.5	.792	.445
26.5	.887	.474	26.5	.792	.483
29.5	**.849**	**.539**	**29.5**	**.750**	**.550**
31.5	.642	.734			
33.5	.642	.751	33.0	.500	.780
36.5	.604	.774	36.5	.500	.799
40.0	.566	.832	40.0	.417	.852
45.5	.264	.966	45.5	.167	.957
50.0	0	1	50.0	0	1

Table 9: Diabetes prevalence by diabetes risk score among the risk score model development and validation sub-groups

Score	Model Development Sub-group			Model Validation Sub-group		
	N	diabetes prevalence		N	diabetes prevalence	
		n	(%)		n	(%)
0-9	75	0	0.0	30	2	6.7
10-19	179	3	1.7	46	2	4.3
20-29	92	5	5.4	39	2	5.1
30-39	188	15	8.0	63	8	12.7
40-49	108	30	27.8	31	10	32.3
Total	**642**	**53**	**8.3**	**209**	**24**	**11.5**

Table 10: the performance of risk score among the risk score model development and validation sub-groups

Score	Model Development Sub-group			Model Validation Sub-group		
	N	diabetes prevalence		N	diabetes prevalence	
		n	(%)		n	(%)
< 29.5	346	8	2.3	115	6	5.2
≥ 29.5	296	45	15.2	94	18	19.1
Total	**642**	**53**	**8.3**	**209**	**24**	**11.5**

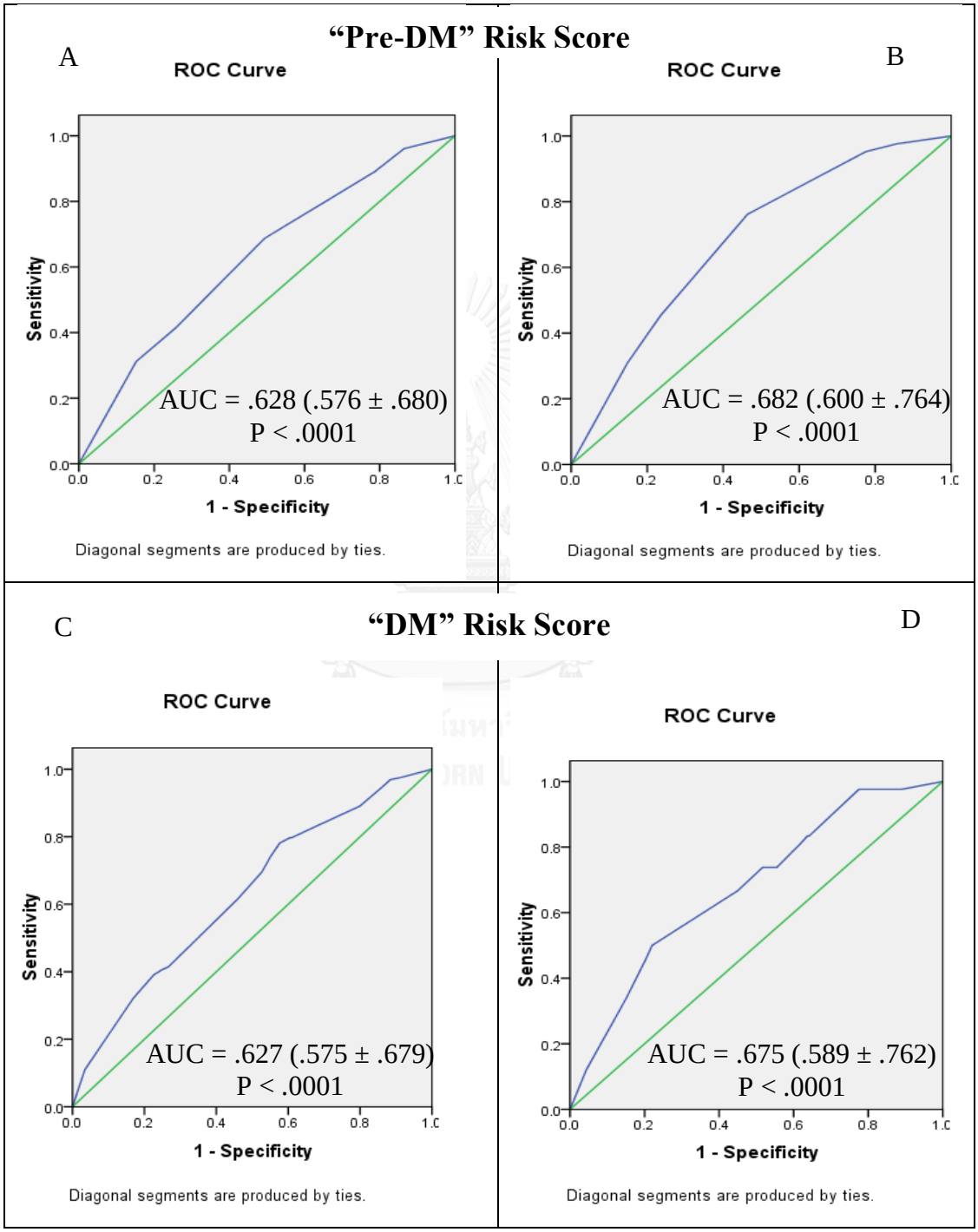
4.4.2 Pre-diabetes risk score

The performance of pre-diabetes risk scores was examined among the remaining 25% of the participants including 209 normal and 42 pre-diabetes individuals, with the total of 251 participants. Two prediction scores were utilized including the first score that was developed specifically for pre-diabetes prediction ("Pre-DM" risk score) and the second one that has been developed for diabetes prediction ("DM" risk score) but was applied for pre-diabetes prediction (Table 8). AUC for the "Pre-DM" risk score for predicting pre-diabetes was 0.682 (95% confidence interval 0.600 - 0.764, p = .0001) (Figure 4, B), which was slightly higher than for the "DM" risk score, which was .675 (95% confidence interval 0.589 - 0.762, p = .0001) (Figure 4, D).

The detail of the sensitivity and specificity according to the cut-off points of these two risk score was shown in table 11. The optimal cutoff point for the "Pre-DM" risk score was ≥ 5.5 with the corresponding sensitivity, specificity and positive predictive value of 0.762, 0.536 and 26.50% respectively, while the optimal cutoff point for the "DM" risk score was 26.5 with the corresponding sensitivity, specificity and positive predictive value of 0.738, 0.483 and 23.86% respectively (Table 12). Increasing "Pre-DM" risk score was clearly related with increased pre-diabetes prevalence (chi-square for linear trend, p < 0.001) (Table 13). The exception was applicable in the individuals with score = 0-2 in the risk score validation group, where the prevalence of the pre-diabetes was 18.0% (Table 13). While "DM" risk score was applied for pre-diabetes prediction, increasing "Pre-DM" risk score was also clearly related with increased pre-diabetes prevalence (chi-square for linear trend, p < 0.001), where the prevalence of the pre-diabetes was 18.0% (Table 14). Additional analysis

“Pre-DM” risk score (Table 15) and “DM” risk score (Table 16) were done by dividing participants into two subgroups based on the cutoff point of 5.5 and 26.5 respectively. The result indicated that the percentages of pre-diabetes participants in the developing and validating subgroup which had score ≥ 5.5 of “Pre-DM” risk score were 26.2 % and 28.3 % then ≥ 26.5. “DM” risk score were 23.1% and 24.4% those who had score < 5.5 were 11.9 % and 8.3 % then had score < 26.5 were 12.6 % and 10.4 % respectively.

Figure 4: the ROC curve analysis of the "Pre-DM" and the "DM" risk scores in predicting pre-diabetes among the risk score model development (A and C) and validation (B and D) sub-groups



Risk score development sub-group

Risk score validation sub-group

Table 11: the performance of the "Pre-DM" risk score at the different cut-off points among the risk score model development and validation sub-groups

Model Development Sub-group			**Model Validation Sub-group**		
risk score	**Sensitivity**	**Specificity**	**Risk score**	**Sensitivity**	**Spesificity**
-1.0	1	0	-1.0	1	.0
.5	.961	.136	.5	.976	.144
3.0	.891	.213	3.0	.952	.225
5.5	**.688**	**.506**	**5.5**	**.762**	**.536**
8.0	.414	.743	8.0	.452	.766
10.5	.313	.847	10.5	.310	.852
12.0	.0	1	12.0	.0	1

The smallest cutoff value is the minimum observed test value minus1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values.

The test result variable(s): Total has at least one tie between the positive actual state group and the negative actual state group.

Table 12: The performance of the "DM" risk score at the different cut-off points for predicting pre-diabetes among the risk score model development and validation sub-groups

Model Development Sub-group			**Model Validation Sub-group**		
risk score [a]	**Sensitivity**	**Specificity**	**risk score** [a]	**Sensitivity**	**Specificity**
-1.0	1	0	-1	1	0
3.5	.977	.083	3.5	.976	.11
9.0	.969	.117	9	.976	.144
12.5	.953	.132	12.5	.976	.163
15.5	.891	.201	15.5	.976	.225
17.5	.797	.391	17.5	.833	.359
19.5	.797	.396	19.5	.833	.364
22.5	.781	.424	22.5	.81	.383
24.5	.742	.449	24.5	.738	.445
26.5	**.695**	**.474**	**26.5**	**.738**	**.483**
29.5	.617	.539	29.5	.667	.55
31.5	.414	.734			
33.5	.406	.751	33	.5	.78
36.5	.391	.774	36.5	.452	.799
40.0	.320	.832	40	.333	.852
45.5	.109	.966	45.5	.119	.957
50.0	.0	1	50	0	1

Table 13: Pre-diabetes prevalence by the "Pre-DM" risk score among the risk score model development and validation sub-groups

score	Model Development Sub-group			Model Validation Sub-group		
	N	prediabetes		N	prediabetes	
		n	%		n	%
score 0-4	139	14	10.1	49	2	4.1
score 5-8	357	62	17.4	124	21	16.9
score 9-12	199	52	26.1	60	19	31.7
Total	**695**	**128**	**18.4**	**233**	**42**	**18.0**

Table 14: Pre-diabetes prevalence by the "DM" risk score among the risk score model development and validation sub-groups

Score	Model Development Sub-group			Model Validation Sub-group		
	N	Pre-diabetes prevalence		N	Pre-diabetes prevalence	
		n	(%)		n	(%)
0-9	75	4	5.3	32	1	3.1
10-19	182	22	12.1	48	6	12.5
20-29	97	23	23.7	41	7	17.1
30-39	203	39	19.2	71	14	19.7
40-49	138	40	29.0	41	14	34.1
Total	**695**	**128**	**18.4**	**233**	**42**	**18.0**

Table 15: The performance of "Pre-DM" risk score among the risk score model development and validation sub-groups

Score	Model Development Sub-group			Model Validation Sub-group		
	N	Pre-diabetes prevalence		N	Pre-diabetes prevalence	
		n	(%)		n	(%)
< 5.5	335	40	11.9	120	10	8.3
≥ 5.5	336	88	26.2	113	32	28.3
Total	**695**	**128**	**18.4**	**233**	**42**	**18.0**

Table 16: the performance of "DM" risk score for predicting pre-diabetes among the risk score model development and validation sub-groups

Score	Model Development Sub-group			Model Validation Sub-group		
	N	Pre-diabetes prevalence		N	Pre-diabetes prevalence	
		n	(%)		n	(%)
< 26.5	310	39	12.6	106	11	10.4
≥ 26.5	385	89	23.1	127	31	24.4
Total	**695**	**128**	**18.4**	**233**	**42**	**18.0**

Chapter V
Discussion

In Laos, it seems that this study is unique in assessing the prevalence of as well as developing and validating the risk score for predicting pre-diabetes and undiagnosed diabetes in Lao population.

5.1. Undiagnosed diabetes and pre-diabetes prevalence

We found that the prevalence of undiagnosed diabetes was 7% and pre-diabetes were 15.5% of adult populations aged 30-70 years. These were higher than the estimated prevalence of only 4.4% for undiagnosed diabetes and 7.78% for pre-diabetes by the International Diabetes Federation (IDF) for Lao population aged 20-79 years in 2013 [1]; moreover our reported prevalence was also higher than previous findings by Pongchaiyakul et al. and King et al. showed the type 2 diabetes prevalence of only 5% and 5.2% for rural ASEAN population aged ≥ 25 and 15-85 years respectively [35, 94], also finding in south-west rural areas of Zhao et al. in China (11.6% of adult people aged ≥ 30 years) [36], King et al. in Siemreap rural areas of Cambodia (10% among those aged ≥ 25 years) for pre-diabetes [94]; these variations might be attributed to the different age ranges of the studied populations This difference might be influenced by regional variation [95, 96], and different clinical characteristic and different origins [97]. However, the type 2 diabetes prevalence for urban ASEAN population reported by King et al. was 11% and Ta et al. was 11.5% [94, 98] were higher than our study. It then should be noted that our study was carried out in the rural area being far from Vientiane center around 30 to 100 kilometers. As we know that rural population has lower risk of type 2diabetes

than urban population [95, 96]. In addition, previous study has reported that the prevalence of type 2 diabetes in asymptomatic individual aged between 30-70 years old in Southeast Asian was 11% in male and 12% in female [98], These prevalence rates were even higher than those of 6% [99] and 8% [100] in developed countries. Furthermore, the prevalence of undiagnosed type 2diabetes and IGT in many Asian countries were also high [101, 102], which could be contributed by many reasons. Firstly, compared to Caucasian populations, the Asian population has high abdominal fat mass and increase insulin resistance with low muscle mass [103]. Then, the fast growing of socioeconomic situation resulted in the change of infrastructure, habitation, the satisfactory food supply that stimulate over nutrition and inactive lifestyles [104]. Accordingly, we predicted that people in this region might share common risk factors for type 2 diabetes, for example, genetic makeup[105], food tradition, environment and climate [106].

5.2. The risk score development for predicting type 2 diabetes and pre-diabetes

Factors significantly associated with the undiagnosed diabetes were age ≥ 40, waist circumference, hypertension, and family history diabetes (parent, sibling), while age ≥ 40, hypertension and BMI was associated with the pre-diabetes in this study. These factors were therefore composed in the equation for predicting the undiagnosed diabetes and pre-diabetes risk.

The Inter ASIA study had proved that IFG and type 2 diabetes are related with the adverse level of cardiovascular risk factors. The estimated prevalence of IFG, type 2 diabetes and their cross-sectional relations with cardiovascular risk factors in ASEAN countries [107-109] and other newly Asia Pacific developing nations [110, 111] seems to be largely attributable to modifications in sociodemographic factors

[112], the increasing level of obesity [113] and in particular with older people [114, 115]. It is important to do the screening in high-risk pre-diabetes subjects, as well as the early prevention or intervention in pre-diabetes subjects to prevent or delay type 2 diabetes.

Age is a non-modifiable factor for type 2 diabetes, and it has been widely used in risk prediction model for type 2diabetes [35, 77, 116-118]. According to our study, age was a strong predictor of type 2 diabetes and pre-diabetes with ≥ 40 years; OR 5.545 ($p < .005$) and 1.684 ($p < .039$) respectively, as previously reported in other parts of the world [119-121]. Also Chaturvedi et al.(age of > 40) [87], Pongchaiyakul et al. (age of 15- 85) [35], and Keesukphan et al. (age of 18-81) [118], these studies showed associated with type 2 diabetes with the odds ratio (OR) of 1.7 ($p < .001$), 1.3 each 5 years increased ($p< .0001$), and 1.06 ($p< .001$) respectively. While Hui Wang et al. [122] and Ouyang Peng et al. [84] showed that the age of ≥ 40 and mean 59.7 ± 15.9 of age were associated with pre- diabetes. Age can be easily applied in the risk score by health care provider to predict and interpret type 2 diabetes risks in such persons. Aging is well-known to be related with decreased muscle mass and increased adiposity due to the habitually noted decreased physical activity. Such alterations are recounted to lead to decreased insulin sensitivity [123, 124], predisposing individuals to pre-diabetes or type 2 diabetes [125, 126].

This study showed that WC contributed strongly to “DM” risk score. While BMI contributed to “Pre-DM” risk score in the model. Among the modifiable risk factors that played a substantial role in previous studies was fatness, as measured by WC or BMI. In this study, only WC was found to increase type 2 diabetes risk and only BMI was found to increase pre-diabetes at cutoff points recommended for Asian

population that are lower than those used for Western countries population (show in table 1) [39, 77]. Nonetheless, the generalization of risk functions can be invalid when applying it across the population with different geographical and ethnic backgrounds [127]. The factors underlying such differences are likely to be the differences in association between clinical risk factors, and the risk of type 2 diabetes across populations and genetic background. For example, the degree of adiposity and BMI association is different between Asian and Caucasians. At the same BMI, the degree of adiposity in Asians is usually higher. Therefore, it is necessary to develop risk score specifically for different groups. Concerning the underlying mechanism of how obesity contributes to the pre-diabetes pathogenesis, there is the well-documented relationship between insulin resistance and obesity with subsequent pancreatic β-cell decompensation in the pathogenesis type 2diabetes [124]. In addition, recent studies have identified obesity induced type 2 diabetes pathogenic pathways comprising increased level of proinflammatory cytokine, cellular process and deranged metabolism of fatty acid, for example, endoplasmic reticulum stress and mitochondrial dysfunction [128]. Body mass index had disadvantages and advantages in identifying overweight and obesity. While WC and body mass index are easy to measure and by far and wide use measurement to reflect general obesity, it does not accurately apply to pregnant women or very muscular athletes such as weight lifters and elderly population [36]. In addition, the effect of obesity on type 2diabetes risk is the long time to become apparent, so obesity was not noted in people with pre-diabetes.

Hypertension is a well-known comorbidity or risk factor of type 2diabetes and pre-diabetes, and including it in the risk score will result in the improved screening

performance for prevalence type 2 diabetes and pre-diabetes. Although Mohan et al. and Ramachandran et al. [116, 129] did not include blood pressure in their diabetes risk score, our study was harmonious with the evidence from a prospective cohort study with the 48-month following-up by Conen et al.[130]; it indicated that blood pressure was a strong and independent predictor of type 2diabetes. Similarly, Anjana et al. had shown pre-diabetes and type 2diabetes condition significant associated with hypertension [131]. A prospective connection between hypertension and type 2diabetes may be affected by a biologic basis. The increased central sympathetic drive could have an effect on hypertension, obesity, in particular central obesity and later type 2diabetes [132-134]. In addition, occurs of hypertension due to two basic defects as insulin resistance and/or β-cell failure. An observation suggested that insulin resistance may be associated with hypertension [135]. Clinical studies have reported that about 50% of hypertensive individuals have glucose intolerance or hyperinsulinemia, while equal to 80% of patients with type 2 diabetes have hypertension [136, 137]. Moreover to its metabolic effects, insulin convinces vasorelaxation by stimulating the production of nitric oxide or NO in endothelium[138] and adjusts sodium homeostasis by increasing sodium reabsorption in the kidney[139, 140]. On the other hand, the risk or a consequence of type 2diabetes from hypertension is probably less relevant to the purpose of identifying high-risk individuals [132-134].

The family history of diabetes was found to be an essential risk factor in many studies [141, 142]. It is the reflection of the genetic predisposition for the diseases and it is an important marker for increased risk of type 2diabetes [143, 144]. Genetic predisposition may be necessary but insufficient for the development of type 2

diabetes. The Researcher proposes that family history should be incorporated into in this kind of model; score value of 7 with the increased of odds ratio 2.079 would probably be appropriate. In addition, the incorporation of family history of diabetes in this model may increase awareness to health care among Lao population, which is still low (74.6%) as inferred from the interview of participants in this study. Our study showed that some participants had never done blood test and never gone to health checkup in health care center.

The proportions of undiagnosed type 2diabetes in the community are approximately 30-60 percent [70, 145]. Undiagnosed type 2diabetes is associated with increased mortality and risk of cardiovascular disease [73, 74]; thus, diabetes risk score may be beneficial on mitigation this public health problem. The identified high risk individuals could delay the onset of type 2diabetes by way of increasing awareness on the modifiable risk factors and having the opportunity to engage in healthy lifestyle. In addition, individuals with a high risk score may actually have unrecognized, asymptomatic diabetes and may require further clinical assessment and therapy. This risk score is a simple, safe, inexpensive prediction tool that could reduce the number of blood glucose assays required at the screening phase.

Although screening rules and risk scores to predicting undiagnosed type 2diabetes [141, 142, 146-148] do available, most of them were developed for Caucasian populations and unnecessarily applicable to Lao population. Some scores used biochemical profiling [149] which might not be practical in Laos context, where health care resources are limited and such test is not easily affordable. Moreover, while it is effective for predicting the future diabetes risk, it might not be so for predicting prevalent undiagnosed type 2diabetes [149]. In addition, these risk scores

used commonly the factors like us such as personal history of hypertension, waist circumference, waist hip ratio, BMI, age, family history, gender [87, 150], although waist-hip ratio, BMI, and gender were not significantly associated with type 2 diabetes in our study. Chaturvedi's study [87] used the risk equation similar to our study but used different cutoffs for the anthropometric (WC in female as >85cm vs. F: ≥ 80 cm) and age scale (>50 vs. 40).

We believe that developing a screening tool in the population will be a safe, simple and practical way to identify individuals at high risk for pre-diabetes and type 2 diabetes in the universal population. It is a cost-efficient tool that is probably to vividly reduce the number of invasive fasting and postprandial blood glucose tests required at the screening phase [150] thus may give a considerable recommendation to apply as the screening tool in public health policy in Lao.

5.3. Validation of risk score

The validation analysis of both "DM" and "Pre-DM" risk score was done by dividing participants into 2 subgroups and used 25% (n= 275 participants) as 209 of normal, 42 of pre-diabetes and 24 of type 2 diabetes from all participants (n=1098 participants). In addition, three prediction scores were utilized including the scores that were developed specifically for type 2 diabetes and pre-diabetes prediction ("DM" and "Pre-DM" risk score) respectively and another one that has been developed for "DM" risk score but was applied for pre-diabetes prediction.

5.3.1. Validation of "DM" risk score

In validating the "DM" risk score, the result showed that our risk score yields the cutoff point 29.5, AUC of .698 (p = .002), .750 of sensitivity, .550 of specificity

were miner difference in the development “DM” risk score with .782 of AUC ($p < .0001$), .849 of sensitivity and .539 of specificity. Similarly margin than other risk score developed previously, AUC of 0.71 ($p = .001$) [118]. However, its generalizability and validity for Lao population other than those in Vientiane needs further investigation since previous studies have shown that the diabetes risk score developed among one population group might not be as valid or generalizable when it was applied in another population group with distinct characteristic [151].

5.3.2. Validation of “Pre-DM” risk score

The validation analysis of “Pre-DM” risk score, the area under the ROC curve (AUC) was .682 ($p < .0001$). The result was similar to our developing “Pre-DM” risk score AUC was .628 ($p < .0001$) and it was similar to another study by Hui Wang et.al. in Guangzhou, China with AUC .70 both male and female ($p < .04$ for male and $p< .038$ for female) [122]. That our “Pre-DM” was good risk score and appropriated for predicting pre-diabetes in Lao population surround Vientiane. However, there was a slightly different of pre-diabetes risk score developed in the USA, with AUC .74 [152]. One potential explanation may be the genetic and environmental causes for pre-diabetes or type 2 diabetes that may vary between ethnic groups. Hui Wang et.al. in Guangzhou, Southwest of China validated pre-diabetes risk score from three studies (southwest and southern of China) in Guangzhou derivation population. The data showed that among three studies, only one study that had a similar genetic background, diet, lifestyle, and climate which can be applied for Hui Wang et. al’s derivation population but not for all Chinese [122].

This study used the cut-off point of risk score ≥ 5.5 and this study had the sensitivity of .762, while the specificity of .536 to predict the risk of pre-diabetes by

FPG. As the comparisons, the sensitivity and specificity of pre-diabetes risk score in Guangzhou, China were 75.5% and 51.4% in male, 77.5% and 49.8% in female [122], and in Chengdu, western China were 74.1% and 58.4% in male; 75.6% and 65.6% in female [153]. In Shanghai, the sensitivity and specificity of urban residents were 68.2% and 61.7% [154] and in the USA, the sensitivity and the specificity were 87.0% and 43.3% [152] respectively. These vary number of sensitivity and specificity in each region may be due to the differences between models of pre-diabetes risk score.

5.3.3. Validation of "DM" risk score predicted pre-diabetes

We applied "DM" risk score predicted pre-diabetes, the result showed that AUC, sensitivity, and specificity of .675 ($p < .0001$), .738, .483 with the cutoff point 26.5 and 5.5 respectively. When compared with the risk score that was developed specifically for pre-diabetes prediction were similar with $p < .0001$. Our "DM" risk score was good to apply predicted pre-diabetes due to the use of "DM" risk score to predict the pre-diabetes prevalence and undiagnosed diabetes may be useful and applicable in the clinical setting especially in Lao population. But previous, models for predicting the risk of developing type 2 diabetes might not be particularly appropriate for individuals with pre-diabetes [122]. Our and previous studies [84, 122] acknowledged that only a few studies have addressed the development of specific "Pre-DM" risk score to identify pre-diabetes. Measuring either FPF or OGTT is an invasive procedure that cannot be applied to all population; it is costly and time-consuming [155]. It is very important to detect high- risk subjects when they are still in a normal blood glucose state and to intervene that prevent their transition from normal blood glucose to pre-diabetes and to overt type 2diabetes [156].

Limitation

This study has some limitations. Firstly, the sample size used in the risk score validation might be inadequate due to some important factors were not significantly associated with pre-diabetes and diabetes. Secondary, we used FPG as the gold standard for diagnosing type 2diabetes instead of OGTT. While the OGTT is greater sensitive and specific than the FPG, many cases would have been detected with the overload of glucose; it is rarely done in the routine clinical practice. Nevertheless, measuring FPG levels may be the best preliminary strategy to screen for diabetes and pre-diabetes [157]. Our idea was to develop simple and widely applicable type 2 diabetes and pre-diabetes screening risk scores. In addition, our study was based on cross-sectional data, thus it is only able to detect prevalence cases of diabetes and pre-diabetes instead a complex process for predicting incident diabetes and pre-diabetes.

Recommendation

We have established the similar pre-diabetes risk score and diabetes risk score for undiagnosed diabetes in this study. It is a simple, cost-efficient, and noninvasive method to predict the risk of pre-diabetes and undiagnosed diabetes. Moreover, our risk score is easy to apply in primary health care workers for screening or assessing the patients who have risk of pre-diabetes (IFG). In the future, it can be used as recommendation for physician to give advice to modify the lifestyle of patients at high risk. In addition to our developed risk score model, the equation is easy to measure. Furthermore, all the risk factors are easily obtained by demographic information and anthropometric measurements. Future study should consider OGTT

as criteria for diagnosis DM. Moreover, cohort study design might be considered to predict incident of diabetes and pre-diabetes in the future study.

Chapter VI
Conclusion

The researchers have developed a simple risk score for screening people at high-risk for type 2 diabetes and pre-diabetes among Lao population. The model of diabetes has included age ≥ 40, waist circumference, hypertension (HTN) and family history diabetes (FDM), which equation = 17(age ≥ 40) + 14(WC) + 11(HTN) + 7(FDM) for "DM" risk score. Its validity was .698, .750 and .550 as inferred from the AUC curve, sensitivity and specificity respectively. And the model of "pre-DM" risk score has included age ≥ 40, hypertension, BMI, which equation = 5(age ≥40) + 5(HTN) + 1(BMI). Its validity was .682, .762 and .536 as concluded from the AUC curve, sensitivity and specificity respectively. When we applied "DM risk score" predicting pre-diabetes was similarly with "pre-DM" risk score, its validity was .675, .738 and .483 as concluded from the AUC curve, sensitivity and specificity respectively. Life-style modification for primary prevention and further blood test should be provided for the population with high risk score.

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APPENDIX

Ethic approval

Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity
===== 000 =====

Ministry of Health
National Institute of Public Health
National Ethics Committee
For Health Research (NECHR)

No. 068/2015 NIOPH/NECHR

Approval Notice

Ms. Souphaphone louangdouangsithidet
Email: s_l_nouan@yahoo.com
Tel: +856 20 22201200

RE: **"A risk scores for predicting prevalence of diabetes in the LAO population"**

Dear Ms. Souphaphone louangdouangsithidet,

Members of the Ethics Committee of the Lao People's Democratic Republic (PDR) have reviewed and approved your research.

Please note the following information about your approved research protocol:

Approval period: December 2015 to December 2016
Approved study samples: 1,082
Sponsor: Chulalongkorn University, Thailand
Implementing Panel/Project Investigator: Ms. Souphaphone louangdouangsithidet

Please note that the Ethics Committee reserves the right to ask for further questions, seek additional or monitor the conduct of your research and consent process.

Vientiane Capital, 03/11/2015
Director General
National Institute of Public Health

ຮອງສາດສະດາຈານ ດຣ ກອງຊັບ ອັກຄະວົງ
Assoc Prof Dr Kongsap AKKHAVONG

Announcements of organization committee and thesis title approval

คำสั่ง คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ที่ 276 /2558
เรื่อง แต่งตั้งคณะกรรมการสอบโครงร่างวิทยานิพนธ์

ด้วยหลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาอาหารและโภชนาการ (หลักสูตรนานาชาติ) ได้กำหนดสอบโครงร่างวิทยานิพนธ์ของ Ms.Souphaphone Louangdouangsithidet รหัสประจำตัวนิสิต 567 68541 37 ในหัวข้อวิทยานิพนธ์เรื่อง "คะแนนความเสี่ยงเพื่อการคาดการณ์ ความชุกของโรคเบาหวานในประชากรลาว" (A RISK SCORES FOR PREDICTING PREVALENCE OF DIABETES IN THE LAO POPULATION) ในวันจันทร์ที่ 27 กรกฎาคม 2558 เวลา 16.00 -18.00 น. และเพื่อให้การดำเนินการดังกล่าวเป็นไปด้วยความเรียบร้อยและมีประสิทธิภาพ จึงขอแต่งตั้งให้ผู้มีรายนามต่อไปนี้เป็นคณะกรรมการสอบโครงร่างวิทยานิพนธ์

1. รองศาสตราจารย์ ดร.สิริชัย อดิศักดิ์วัฒนา ประธานกรรมการ
2. ผู้ช่วยศาสตราจารย์ ดร.สุวิมล ทรัพย์วโรบล อาจารย์ที่ปรึกษาวิทยานิพนธ์หลัก
3. รองศาสตราจารย์ นพ.วิโรจน์ เจียมจรัสรังษี อาจารย์ที่ปรึกษาวิทยานิพนธ์ร่วม
4. แพทย์หญิงสิริเนตร กฤติยาวงศ์ กรรมการภายนอกมหาวิทยาลัย

ทั้งนี้ ตั้งแต่บัดนี้เป็นต้นไป จนกว่าจะแล้วเสร็จ

สั่ง ณ วันที่ 20 กรกฎาคม พ.ศ. 2558

(รองศาสตราจารย์ ดร.ประวิตร เจนวรรธนะกุล)
คณบดีคณะสหเวชศาสตร์

Screening process form in English and Lao langue

Screening process form in English langue

Screening process

(By interview and Physical examination)

Title of this study: A risk scores for predicting prevalence of diabetes in the Lao population.

The questionnaire for this examination is divided into two sessions.

Session 1: Interview and Physical examination on Diabetes Risk Score. There are 2 steps.

1. Screening for eligibility of participants.

   The inclusion criteria are:

   1.1 Aged from 30 to 70 years old.

   1.2 Be able and willing to participate in the next fasting plasma glucose (FPG) test (session2).

   1.3 Not having diabetes (undiagnosed).

   1.4 Not using medicine associated to diabetes treatment and not taking drug having effect on blood sugar level (steroid drug or containing steroid compounds).

The participants who met all above criteria would be eligible for this study.

2. Physical examination and interviewing about histories/behaviors on the diabetes risks of participants.

2.1. Body Mass Index

2.2. Waist circumference

2.3. Waist-to-hip ratio.

2.4. Hypertension

2.5. Antihypertensive drug (use medication to treat hypertension).

2.6. Family history of diabetes.

2.7. Physical inactivity (< 150 min/week or 3 day/week).

2.8. Smoking.

2.9. History of Dyslipidemia.

LDL-L > 100 mg/dl, HDL <50 mg/dl, Triglyceride > 150 mg/dl

2.10. Intake Dyslipidemia drug.

2.11. History of gestational diabetes.

2.12. History deriver a baby weighing > 4 kg.

All participants who have completely passed the screening session 1 will continue with FPG test in session 2.

Questionnaire form

Name and Surname: .....

Age: .....

Gender: ☐ male ☐ female

Mobile phone: .....

E-mail/ Facebook: .....

Residence: Village: .....

District: .....

Occupation: ☐ Government employee ☐ Non- government employee

☐ Self- employee ☐ Farmer unemployed

Other .....

Education: ☐ primary schooling completed ☐ Second schooling completed

☐ High schooling completed ☐ College

Other .....

Ethnicity: ☐ LaoLoum ☐ Lao Theung ☐ Lao Soung

Other .....

Session1: Interview and Physical examination Form on Diabetes Risk Score Assessment

Step 1: Selection of eligibility of participants by interviewing using following criteria

No		Answer	
1.1	Age ≥ 35 to 70 years old (not over 70 year):	☐ yes	☐ No
1.2	Voluntary participant in this study examination	☐ yes	☐ No
1.3	Having diabetes.	☐ yes	☐ No
1.4	Taking diabetes medicine	☐ yes	☐ No
1.5	Taking drug affecting level of blood sugar that contains steroid or steroid compounds	☐ yes	☐ No

Interviewee having answers "yes" in 1 & 2 and "no" in 3, 4, 5 questions could pass to the step 2

Step 2: Interviewing and physical examination participants for checking risk factors associated with diabetes.

No	Risk factor is associated with diabetes.	Answer	
2.1.	Family history of diabetes	☐ yes	☐ No
	How many people in families have diabetes.....,		
	Such as		
2.2.	Antihypertensive drug (use medication to treat hypertension)	☐ yes	☐ No
2.3.	Physical inactivity (< 150 min/week or 3 day/week)	☐ yes	☐ No

2.4. Smoking ..... ☐ yes ☐ No

2.5. History dyslipidemia ..... ☐ yes ☐ No

LDL-L > 100 mg/dl ..... ☐ yes ☐ No

HDL < 35 mg/dl ..... ☐ yes ☐ No

Triglyceride > 150 mg/dl ..... ☐ yes ☐ No

2.6. Intake Dyslipidemia drug ..... ☐ yes ☐ No

2.7. History of gestational diabetes ..... ☐ yes ☐ No

2.8. History deriver a baby weighing > 4 kg ..... ☐ yes ☐ No

2.9. Body Mass Index:..... Kg/m^2

Height.....cm

Weight.....cm

2.10 Hip circumference: Male .....cm

female .....cm

2.11 Waist circumference: Male .....cm

female .....cm

2.12 Waist-to-hip ratio:..... .

2.13 Hypertension: ..... mmHg

Date:.....

Examiner Name:.....

Signature.....

Screening process form in Lao langue

ລະຫັດ:...................

ສາທາລະນະລັດ ປະຊາທິປະໄຕ ປະຊາຊົນລາວ

ສັນຕິພາບ ເອກະລາດ ປະຊາທິປະໄຕ ເອກະພາບ ວັດທະນະຖາວອນ

****

ຂະບວນການກວດສຸຂະພາບ ຂອງການວິໄຈ ລະຫັດ:

(ໂດຍການສຳພາດ ແລະ ການກວດຮ່າງກາຍ)

ຫົວຂໍ້ຂອງການສຶກສາຄັ້ງນີ້: ຄະແນນຄວາມສ່ຽງ ເພື່ອຄາດຄະເນ ຄວາມຊຸກຊຸມຂອງເບົາຫວານໃນປະຊາຊົນລາວ.

ຂະບວນການກວດສຸຂະພາບ ຂອງການວິໄຈນີ້ ແບ່ງອອກເປັນ 2 ໄລຍະ.

<u>ໄລຍະທີ 1</u>: <u>ການສຳພາດ</u> ແລະ <u>ການກວດຮ່າງກາຍ ກ່ຽວກັບຄະແນນຄວາມສ່ຽງຂອງ</u>ເບົາຫວານ. ໃນນີ້ ມີ 2 ຂັ້ນຕອນ ດັ່ງລຸ່ມນີ້.

1. ການຄັດເລືອກ ຜູ້ເຂົ້າຮ່ວມການວິໄຈ.

   ເງື່ອນໄຂໃນການຄັດເລືອກ:

   1.1 ມີອາຍຸລະຫວ່າງ 30 ຫາ 70 ປີ.
   1.2 ມີຄວາມເຕັມໃຈ ແລະ ຕົກລົງ ສະໝັກເຂົ້າຮ່ວມ ການວັດແທກລະດັບນ້ຳຕານໃນເລືອດ fasting plasma glucose (ໃນໄລຍະທີ 2).
   1.3 ບໍ່ເຄີຍເປັນເບົາຫວານມາກ່ອນ (ບໍ່ຮູ້ຈັກວ່າຕົນເອງເປັນເບົາຫວານ)
   1.4 ບໍ່ກິນຢາລຶດລະດັບນ້ຳຕານໃນເລືອດ ຫຼື ຢາທີ່ມີຜົນເຮັດໃຫ້ລະດັບນ້ຳຕານໃນເລືອດລຶດລົງ. (ມີການສອບຖາມຂໍ້ມູນ ຊື່ຢາ ທີ່ກຳລັງກິນຢູ່).

   ຜູ້ເຂົ້າຮ່ວມ ທີ່ຄົບຕາມເງື່ອນໄຂທັງໝົດຂ້າງເທິງ ຈະຖືກເຊີນເຂົ້າຮ່ວມໃນການວິໄຈຄັ້ງນີ້

2. ການສຳພາດກ່ຽວກັບປະຫວັດ-ປັດໄຈ ທີ່ມີຄວາມສ່ຽງໃນການເປັນພະຍາດເບົາຫວານ ແລະ ການກວດຮ່າງກາຍຂອງຜູ້ເຂົ້າຮ່ວມ.
   - 2.1. ມາດຕະຖານຄວາມຕຸ້ຍ ອີງຕາມດັດຊະນີມວນກາຍ ຫຼື BMI (ນ້ຳໜັກເປັນກິໂລກຣາມຫານດ້ວຍ ລວງສູງເປັນແມັດ ຂຶ້ນກຳລັງ 2)
   - 2.2. ຮອບແອວ
   - 2.3. ສັດສ່ວນຮອບແອວຫານຮອບສະໂພກ (Waist-to hip ratio)
   - 2.4. ຄວາມດັນເລືອດ
   - 2.5. ກິນຢາລຶດຄວາມດັນເລືອດ.

ລະຫັດ:.....,

2.6. ປະຫວັດຄອບຄົວເປັນເບົາຫວານ (ພໍ່, ແມ່,ເອື້ອຍ/ອ້າຍ/ນ້ອງ).
2.7. ບໍ່ອອກກຳລັງກາຍ (ປະຕິບັດນ້ອຍກ່ວາ 150 ນາທີ/ອາທິດ ຫລື 3 ວັນ/ອາທິດ).
2.8. ສູບຢາ.
2.9. ຜ່ານມາ ຫຼື ປັດຈຸບັນມີໄຂມັນໃນເລືອດສູງເຊັ່ນ:
  2.9.1. LDL-L > 100 mg/dl
  2.9.2. HDL < 50 mg/dl
  2.9.3. Triglyceride > 150 mg/dl
2.10. ກິນຢາລົດລະດັບໄຂມັນໃນເລືອດ.
2.11. ປະຫວັດເປັນເບົາຫວານໃນເວລາຖືພາ.
2.12. ປະຫວັດເກີດລູກນ້ຳໜັກຫຼາຍກ່ວາ 4 kg.

ຜູ້ເຂົ້າຮ່ວມ ທີ່ຜ່ານການກວດຮ່າງກາຍ ແລະ ສຳພາດໃນໄລຍະທີ 1 ຄົບຖ້ວນແລ້ວ ຈະສືບຕໍ່ເຂົ້າຮ່ວມ ການວິເຄາະລະດັບນ້ຳຕານໃນເລືອດ FPG ໃນໄລຍະທີ 2.

ໄລຍະ ທີ2: ການວິເຄາະລະດັບນ້ຳຕານໃນເລືອດ (FPG test)

ຜູ້ເຂົ້າຮ່ວມ ຈະຕ້ອງປະຕິບັດຕາມຄຳແນະນຳ ເພື່ອກຽມຕົວສຳລັບການວິເຄາະລະດັບນ້ຳຕານໃນເລືອດດັ່ງນີ້:

1. ອົດອັບປະທານອາຫານ ແລະເຄື່ອງດື່ມ ຢ່າງນ້ອຍ 8-14 ຊົ່ວໂມງ ກ່ອນການກວດເລືອດທີ່ຈະປະຕິບັດ ໃນມື້ຕໍ່ມາ.
2. ບໍ່ມີຄຳແນະນຳ ຫລື ຂໍ້ຫ້າມຕ່າງໆ ກ່ຽວກັບຊະນິດ ແລະປະລິມານ ໃນການບໍລິໂພກອາຫານ ກ່ອນໜ້າ ການອົດອາຫານນີ້ ກໍຄືສາມາດບໍລິໂພກອາຫານປະຈຳວັນໂດຍປົກກະຕິ.

ຄ່າປົກກະຕິຂອງລະດັບນ້ຳຕານໃນເລືອດ(normal level of FPG) ແມ່ນ "< 100 mg/dl",

ຄ່າຜິດປົກກະຕິ (Impaired Fasting Glucose) ແມ່ນ "100-125 mg/dl" ແລະ

ຄ່າທີ່ເປັນພະຍາດເບົາຫວານ ແມ່ນ ">126 mg/dl"

(ອີງຕາມ ສະຫະພັນພະຍາດເບົາຫວານ ອາເມຣິກັນ (ADA) 2013).

ຜູ້ເຂົ້າຮ່ວມການວິໃຈທຸກຄົນ ຈະໄດ້ຮັບຮູ້ຜົນຂອງການວິໃຈຂອງຕົນ ແລະ ຜູ້ທີ່ມີຜົນກວດຜິດປົກກະຕິ ຈະໄດ້ ຮັບຄຳແນະນຳ ກ່ຽວກັບ ການດຸແລສຸຂະພາບ ລວມທັ້ງ ການແນະນຳໃຫ້ປຶກສາທ່ານໝໍເພື່ອປິ່ນປົວໃນຕໍ່ໜ້າ.

ລະຫັດ:.....,

ແບບຟອມການສຳພາດແລະກວດກາສຸຂະພາບ

ຊື່ ແລະ ນາມສະກຸນ:.....,ອາຍຸ:.....ປີ

ເພດ: ☐ ຊາຍ ☐ ຍິງ

ເບີໂທ:.....,ອີເມວ/ ເຟດບຸກ:.....

ທີ່ຢູ່ປະຈຸບັນ: ບ້ານ:.....,ເມືອງ:.....

ອາຊີບ: ☐ ພະນັກງານລັດ ☐ ພະນັກງານລັດວິສະຫະກິດ

☐ ທຸລະກິດສ່ວນຕົວ/ຄ້າຂາຍ ☐ ຊາວນາ/ຊາວສວນ

ອື່ນໆ.....

ລະດັບການສຶກສາ: ☐ ຈົບປະຖົມ ☐ ຈົບມັດທະຍົມຕົ້ນ

☐ ຈົບມັດທະຍົມປາຍ ☐ ວິທະຍາໄລ

ອື່ນໆ.....

ຊົນເຜົ່າ: ☐ ລາວລຸ່ມ ☐ ລາວເທິງ ☐ ລາວສູງ

ອື່ນໆ.....

<u>ແບບຟອມໄລຍະທີ 1: ການສຳພາດ ແລະ ການກວດຮ່າງກາຍ ກ່ຽວກັບການປະເມີນຄະແນນຄວາມສ່ຽງຂອງເບົາຫວານ.</u>

<u>ຂັ້ນຕອນ ທີ1:</u> ການສຳພາດເພື່ອຄັດເລືອກ ຜູ້ເຂົ້າຮ່ວມການວິໃຈ ອີງຕາມເງື່ອນໄຂການຄັດເລືອກ

ລ/ດ		ຄຳຕອບ
1.1	ມີອາຍຸລະຫວ່າງ 30 ຫາ 70 ປີ:	☐ແມ່ນ ☐ ບໍ່
1.2	ມີຄວາມສະໝັກໃຈດ້ວຍຕົນເອງເພື່ອເຂົ້າຮ່ວມການວິໃຈນີ້	☐ແມ່ນ ☐ ບໍ່
1.3	ມີພະຍາດເບົາຫວານ.(ຮູ້ວ່າຕົນເອງເປັນແລ້ວ)	☐ແມ່ນ ☐ ບໍ່
1.4	ໄດ້ນຳໃຊ້ຢາກ່ຽວກັບພະຍາດເບົາຫວານ	☐ແມ່ນ ☐ ບໍ່
1.5	ໄດ້ນຳໃຊ້ຢາລົດລະດັບນ້ຳຕານໃນເລືອດ ' ຫລື ຢາທີ່ມີຜົນເຮັດໃຫ້ ລະດັບນ້ຳຕານໃນເລືອດ	☐ແມ່ນ ☐ ບໍ່

ຜູ້ເຂົ້າຮ່ວມ ທີ່ມີຄຳຕອບ "ແມ່ນ" ໃນຄຳຖາມຂໍ້ 1.1 & 1.2 ສາມາດຜ່ານເຂົ້າຮ່ວມໃນການວິໃຈ ໃນຂັ້ນຕອນ ທີ2. ແລະ " ແມ່ນ " ໃນຂໍ້ 1.3, 1.4, 1.5 ຢຸດການສຳພາດຂໍ້ຕໍ່ໄປ.

<u>ຂັ້ນຕອນ ທີ2</u>: ການສຳພາດ ແລະ ການກວດຮ່າງກາຍ ເພື່ອປະເມີນຄະແນນຄວາມສ່ຽງໃນການເປັນເບົາຫວານ ຂອງຜູ້ເຂົ້ຮ່ວມ.

ລະຫັດ:.....,

ລ/ດ	ຄະແນນຄວາມສ່ຽງໃນການເປັນເບົາຫວານ	ຄຳຕອບ
2.1.	ປະຫວັດຄອບຄົວເປັນເບົາຫວານ	☐ແມ່ນ ☐ ບໍ່
	ມີ ພໍ່, ແມ່,ເອື້ອຍ/ອ້າຍ/ນ້ອງ ຄົງເປັນເບົາຫວານຈັກຄົນ?.....	
	ຄືດັ່ງນີ້	
2.2.	ກິນຢາລົດຄວາມດັນເລືອດ	☐ແມ່ນ ☐ ບໍ່
2.3.	ບໍ່ອອກກຳລັງກາຍ (ນ້ອຍກ່ວາ 150 ນາທີ / ອາທິດ ຫລື 3 ວັນ /ອາທິດ).....	☐ແມ່ນ ☐ ບໍ່
2.4.	ສູບຢາ	☐ແມ່ນ ☐ ບໍ່
2.5.	ມີປະຫວັດ ຫຼື ປັດຈຸບັນມີໄຂມັນໃນເລືອດສູງເຊັ່ນ:	☐ແມ່ນ ☐ ບໍ່
	LDL-L > 100 mg/dl	☐ແມ່ນ ☐ ບໍ່
	HDL < 35 mg/dl	☐ແມ່ນ ☐ ບໍ່
	Triglyceride > 150 mg/dl	☐ແມ່ນ ☐ ບໍ່
2.6.	ກິນຢາລົດລະດັບໄຂມັນໃນເລືອດ.....	☐ແມ່ນ ☐ ບໍ່
2.7.	ມີປະຫວັດເປັນເບົາຫວານໃນເວລາຖືພາ.....	☐ແມ່ນ ☐ ບໍ່
2.8.	ມີປະຫວັດເກີດລູກນ້ຳໜັກ > 4 kg	☐ແມ່ນ ☐ ບໍ່
2.9.	ດັດສະນີມວນກາຍຫລື BMI (ພາວະຄວາມຕຸ້ຍ):.....Kg/m^2	
	ລວງສູງ.....cm, ນ້ຳໜັກ.....Kg	
2.10.	ຮອບແອວ: ເພດຊາຍ.....cm	
	ເພດຍິງ.....cm	
2.11.	ຮອບສະໂພກ: ເພດຊາຍ.....cm	
	ເພດຍິງ.....cm	
2.12.	ສັດສ່ວນຮອບແອວ ຫານ ຮອບສະໂພກ.....	
2.13.	ຄວາມດັນເລືອດ:..... mmHg	

ວັນທີ:.....

ຊື່ ຜູ້ສຳພາດ-ກວດກາ:.....

ລາຍເຊັ່ນ:.....

Information of study participants in English langue

LAO PEOPLE'S DEMOCRATIC REPUBLIC
PEACE INDEPENDENCE DEMOCRACY UNITY PROSPERITY

****

Information of study participants

Title: A risk scores for predicting prevalence of diabetes in the LAO population

Investigator:

Student: Mrs. Souphaphone Louangdouangsithidet, master student in Food and Nutrition Science Program, Faculty of Allied Health Sciences, Chulalongkorn University, Thailand.

Place of contact Investigator: Out Patient department, Mahosot hospital, or Xayfongneua village, Hadxayfong district, Vientiane capital. Mobile phone: 020 22201200 (Lao), 083 839 6120 (Thai). Email: s_l_nouan@yahoo.com

Advisor: Assistant Prof. Dr. Suwimol Sapwarobol, RD. head of department of Nutrition and Dietetics, faculty of Allied Health Sciences, Chulalongkorn University, Thailand.

Place of contact Investigator: department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Chulalongkorn University 154, soi chula 12, King Ramar 1 road, phathumvan subdistrict, vangmai district, Bangkok 10330, Tel: +66 2-218-1116, Fax: + 66 2 218 1116. Email: ssapwarobol@gmail.com

We would like to invite you as study participant in our research. Before you decide to attend this research, we would like to let you understand about this research, why we

need to do this research? What are the advantages and disadvantages from this research? Please read carefully this following information. Please ask for any further information.

Detail of research information

The prevalence of diabetes, a growing global health problem, is increasing rapidly worldwide. In addition, the impact of diabetes provides the burden problem leading to increase the cost for the treatment and cause of deaths. However, the important steps to prevent and/or delay the onset of type 2 diabetes and its complications are to identify people with prediabetes and undiagnosed diabetes in order to provide an appropriate care. To address this problem, several investigators have developed diabetes risk assessment model in simply, less expensive, more convenient and noninvasive method for predicting the diabetes prevalence. Lao PDR has no clear data sources examining the prevalence of diabetes and has not developed the risk score for predicting prevalence of diabetes. To our knowledge, risk assessment model might possibly provide prediction in diabetes prevalence, particularly as undiagnosed diabetes in Lao population. Therefore, in this study, we aimed to develop risk scores for predicting prevalence of diabetes in Lao population.

Objective

Aim of this study is to develop risk scores for predicting prevalence of diabetes in Lao population. Specifically objectives are:

- to assessed the prevalence of diabetes by using fasting plasma glucose test in Lao population
- to develop the diabetes risk score associated with predicting diabetes in Lao population

- to validate diabetes risk score in high risk population

Step of research

This research will start on October 1015 to July 2016; need 1,082 of participants, located at Hadxayfong, Pargneum, and Naxaythong district, Vientiane capital, Lao PDR. Participants will have this following step of research.

Interview: age, gender, history family diabetes include parents and sibling, female with history of having baby weighing more than 4 kg, gestational diabetes, and history or current present of dyslipidemia (triglycerides >150 mg/dl, LDL-C ≥ 100 mg/dl, HDL-c < 35 mg/dl), smoking habit, physical inactivity (less than 150 min/week or 3 day/week).

Physical exam: body weight and height measurement, body mass index, waist circumference (WC) and hip circumference and blood pressure assessment.

Fasting Plasma Glucose (after fasting overnight at lead 8 hours) for diagnostic diabetes

Participants who can include this study:

Aged from 30 to 70 years old

Be able and willing to participate in the next FPG test (session2).

Not having diabetes (undiagnosed).

Not using medicine associated to diabetes treatment and not taking drug having effect on blood sugar level (steroid drug or containing steroid compounds).

Advantage and disadvantage

Advantage

Participant will receive fasting plasma glucose test for screening of diabetes. The results (screening of undiagnosed diabetes) may provide the early

prevention/treatment of diabetes, possibly the person who are having diabetes may have better awareness and motivation to take care of their condition; and for health care providers, this research may benefit to initiate/motivate them to provide better surveillance in community or treatment for individuals who are either categorized as having diabetes or at risk group from this research. Furthermore, in the future, this research may give a new insight for academicians, community, and health care providers especially governmental institution to look for non-invasive risk assessment tools to predict diabetes in Lao population and so the initiation of early diagnosis may possibly delay the diabetic-related disease, such as heart disease (cardiovascular/coronary heart disease), kidney disease (nephropathy), liver disease, or any diabetic-diseases affected to nerve (neuropathy), eye (retinopathy), diabetic-foot disease (gangrene), etc.

Disadvantage:

This research will provide blood glucose test by well-experienced nurse, however, there is a side effect from taking blood sample such as swelling around arms (vein puncture), redness, bleeding, or possible induce dizziness (if this condition happen, researcher will responsible for checking their condition to the physicians in the hospital).

If any inconvenience occurs during this research, participant is allowed to quit from this research.

Confidential information of research participants

All personal information about participants will be kept as confidential data and will not distributed to any of person/institution. The findings of this result (prevalence of

diabetes and diabetes risk score) will be used as research data and perhaps will be a basic data for diabetic surveillance in community.

VITA

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