VALIDATION OF THE STANDARD FIELD SOBRIETY TESTS FOR DETERMINING ALCOHOL INTOXICATION

PAWIT KATAKOT

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE (EPIDEMIOLOGY)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2007

Thesis
Entitled

VALIDATION OF THE STANDARD FIELD SOBRIETY TESTS FOR DETERMINING ALCOHOL INTOXICATION

PAWIT KATAKOT
.....
Mister Pawit Katakot
Candidate

.....
Assist. Prof. Teera Kolladarungkri,
M.D., Dip Thai Bod Int Med.
Major-Advisor

Chatchawan Silpakit
.....
Assist. Prof. Chatchawan Silpakit
M.D., Ph.D. (Psychiatric Epidemiology)
Co-Advisor

Kitiphong H.
.....
Lect.Kitiphong Harncharoen,
Ph.D.(Biological Science)
Co-Advisor

.....
Prof. M.R. Jisnuson Svasti, Ph.D.
Dean
Faculty of Graduate Studies

Prasert Assantachai
.....
Assoc. Prof. Prasert Assantachai
M.D. (Hons), F.R.C.P. (London)
Chair
Master of Science Programme in
Epidemiology
Faculty of Medicine, Siriraj Hospital

Thesis
Entitled

VALIDATION OF THE STANDARD FIELD SOBRIETY TESTS FOR DETERMINING ALCOHOL INTOXICATION

Was submitted to the faculty of Graduate Studies, Mahidol University
For the degree Master of Science (Epidemiology)
on
1 June 2007

PAWIT KATAKOT
.....
Mister Pawit Katakot
Candidate

.....
Assist. Prof. Teera Kolladarungkri,
M.D., Dip Thai Bod Int Med.
Chair

Chatch Silpakit
.....
Assist. Prof. Chatchawan Silpakit
M.D., Ph.D. (Psychiatric Epidemiology)
Member

Paisan Worasathit
.....
Mr. Paisan Worasathit
M.D., Dip. Thai Board of Orthopaedics
Dip. Thai Board of Preventive Medicine
Dip. Thai Board of Family Medicine
Ph.D. in Development Science
Member

Kitiphong H.
.....
Lect.Kitiphong Harncharoen
Ph.D.(Biological Science)
Member

.....
Prof. M.R. Jisnuson Svasti, Ph.D.
Dean
Faculty of Graduate Studies
Mahidol University

P. Sakolsatayadorn
.....
Prof. Piyasakol Sakolsatayadorn
M.D., F.R.C.S.T
Dean
Faculty of Medicine, Siriraj Hospital
Mahidol University

ACKNOWLEDGMENT

This thesis had been accomplished by the collaboration of many wonderful persons. I would like to express my sincere gratitude and deep appreciation to Assistant Professor Teera Kolladarungkri, my principle supervisor, for his guidance, invaluable advice, supervision and encouragement throughout the work of the thesis. He has never lacked of kindness and support. I am equally grateful to Assistant Professor Chatchawan Silpakit and Dr. Kitiphong Harncharoen my co-advisors, for their constructive comments, supervision and encouragement. I would also like to thank Dr. Wichai Khatiyavitayagul who permits me to study in master degree at Mahidol University and Dr. Paisan Worasathit my external co - advisor for valuable advice and support in the defense of the thesis.

Very special thanks to volunteers in the Muang district at Buriram province. I am particularly thankful to the Don't Drive Drunk Foundation, for the partial thesis grant, which enabled me to undertake the study.

Finally, I am extreme gratefully to my family for their infinite love, kindness, understanding and support throughout my study. My sincere thanks are given to my lovely friends for their assistance and kindly support.

Pawit Katakot

VALIDATION OF THE STANDARD FIELD SOBRIETY TESTS FOR DETERMINING ALCOHOL INTOXICATION

PAWIT KATAKOT 4637813 SIEP/M

M.Sc. (EPIDEMIOLOGY)

THESIS ADVISORS: TEERA KOLLADARUANGKRI, M.D., Dip Thai Bod Int Med., CHATCHAWAN SILPAKIT, M.D., Ph.D. (Psychiatric Epidemiology), KITIPHONG HARNCHAROEN, Ph.D. (Biological Science)

ABSTRACT

This research is a population-based cross-sectional analytical study which studied the reliability of Standard Field Sobriety Tests compared with breath analyzer tests to determine alcohol intoxication of 103 healthy volunteers whose age range was from 20-40. All volunteers had to drink alcoholic beverages and undergo the testing conducted by well trained assistants. Each testing method had a high inter-rater reliability (Horizontal Gaze Nystagmus, Walk and Turn and One leg stand were 0.968 (95%CI=0.907-0.991), 0.977 (95%CI=0.931-0.994) and 0.977 (95%CI=0.931-0.994).

Results of the study showed that 76.7% of male volunteers, had blood alcohol concentration averaging 58.3 mg%. Duration of the test administration for the 3 methods was 3.56 minutes. Criteria to decide the alcohol intoxication using the 3 testing methods is score = 1. For the HGN test, given the cut point of BAC 30 mg% provided a level of accuracy of 93.2%, sensitivity = 97.1%, specificity = 84.8%, and the excellent agreement was 0.840. For WAT and OLS tests, given the cut point of BAC 50 mg%, the Walk and Turn possessed sensitivity, specificity, and accuracy of 76.4%, 64.6%, and 70.9% respectively, and agreement value 0.412, while the value of One Leg Stand was 45.5%, 85.4%, and 64.1% respectively and kappa statistic was 0.300. HGN has the most reliable value when comparing the cut point of BAC at 50 mg%, which means the person is intoxicated based on the standard legal limit i.e. accuracy=78.7%, sensitivity = 70.9%, specificity = 87.5%, and kappa = 0.576.

The Standard Field Sobriety Tests are still not legally applicable. However, it should be used to conduct preliminary tests in drunk drivers to reduce numbers on the road using the HGN test.

KEY WORDS : STANDARD FIELD SOBRIETY TEST/ HORIZONTAL GAZE NYSTAGMUS/ WALK AND TURN/ ONE LEG STAND

96 pp.

ความน่าเชื่อถือของเครื่องมือ Standard Field Sobriety Testsในการทดสอบคนเมาแอลกอฮอล์ (VALIDATION OF THE STANDARD FIELD SOBRIETY TESTS FOR DETERMINING ALCOHOL INTOXICATION)

ปวิตร คตโคตร 4637813 SIEP/M

วท.ม.(วิทยาการระบาด)

คณะกรรมการควบคุมวิทยานิพนธ์ : ธีระ กลดาเรืองไกร, M.D., Dip Thai Bod Int Med., ชัชวาลย์ ศิลปกิจ, M.D., Ph.D. (Psychiatric Epidemiology), กิติพงษ์ หาญเจริญ, Ph.D. (Biological Science)

บทคัดย่อ

การศึกษาชนิด population-based cross-sectional analytical study เพื่อศึกษาความน่าเชื่อถือของ Standard Field Sobriety Tests เปรียบเทียบกับการใช้เครื่องวัดระดับแอลกอฮอล์ทางลมหายใจในการทดสอบคนเมา ในประชากรอายุตั้งแต่ 20 - 40 ปี มีสุขภาพร่างกายแข็งแรงจำนวน 103 คน เป็นอาสาสมัครที่ต้องดื่มแอลกอฮอล์แล้วทำการทดสอบด้วยเครื่องมือโดยผู้ทดสอบที่ได้รับการฝึกอบรมเป็นอย่างดี มีค่า inter-rater reliability สูง (Horizontal Gaze Nystagmus (HGN) = 0.968, Walk and Turn (WAT)=0.977 และ One leg stand (OLS) =0.977

ผลการศึกษาพบว่าประชากรที่ศึกษาเป็นอาสาสมัครเพศชาย 76.7% มีระดับแอลกอฮอล์เฉลี่ย 58.3 mg% ระยะเวลาในการทดสอบทั้งสามวิธี 3.56 นาที เกณฑ์ตัดสินว่าเมาของทั้งสามวิธีที่ให้ค่าความน่าเชื่อถือดีที่สุด คือที่ 1 คะแนน เมื่อใช้จุดตัดระดับแอลกอฮอล์ของ HGN ที่ 30mg% มีค่า Accuracy = 93.2%, sensitivity = 97.1%, specificity = 84.8%, และค่าความสอดคล้องเท่ากับ 0.840 ส่วนการทรงตัวทั้งสองใช้จุดตัดที่ 50mg%: walk and turn, มีค่า sensitivity, specificity, และ accuracy เท่ากับ 76.4%, 64.6%, และ 70.9% ตามลำดับ และมีค่าความสอดคล้องอยู่ในระดับพอใช้ถึงดี (0.412) ส่วน one leg stand มีค่า Accuracy = 45.5%, sensitivity = 85.4%, specificity = 64.1% มีค่าความสอดคล้องต่ำ (0.300) เมื่อเปรียบเทียบกันที่จุดตัดระดับแอลกอฮอล์เดียวกันที่ 50 mg% ซึ่งถือว่าเมาตามกฎหมายที่กำหนดไว้ HGN มีค่าความน่าเชื่อถือดีที่สุด (accuracy=78.7, sensitivity = 70.9%, specificity = 87.5%, และ kappa = 0.576)

จากการศึกษานี้ยังไม่สามารถนำเครื่องมือนี้ไปบังคับใช้ตามกฎหมายเช่นเดียวกับการใช้เครื่องวัดระดับแอลกอฮอล์ทางลมหายใจ แต่สามารถนำไปใช้สำหรับการคัดกรองเบื้องต้นในผู้ที่ดื่มแอลกอฮอล์เพื่อลดการเกิดอุบัติเหตุจากการเมาแล้วขับ โดยใช้ HGN เพียงวิธีเดียว

96 หน้า

CONTENTS

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

CHAPTER I
INTRODUCTION

1.1 BACKGROUND AND SIGNIFICANCE OF THE PROBLEM

Accident, an important health problem, was the second major causes of death after AIDS in Thailand more than ten years. (approximately 50 per 100000 persons per year).(1) The Bureau of Disease for Priority of Health Problem in Thailand 1999 was reported that 6.6 percent cause of death was traffic accident which was the second order after AIDS. (2) Traffic accident was recorded the highest accident that occurred comparing to other causes of accident. Trend of mortality rate resulting from traffic accident varied during 1987 to 2002. It increased from 22 per100000 persons in 1993 to 28 per 100000 persons in 1996, then, decreased to the lowest rate to 12.8/100000 persons in 1998, after which the trend has continued to increase year by year. (3). The mortality rate occurred in male more than female, age was between 15 to 29 years, and 3 out of 4 traffic accidents found the patients were motorists. The mortality rate has been particularly high during songkran festival and long weekend.

The risk factor of traffic accident was drunk driving. In 1994, Siriraj Hospital reported that 81.2 percent of motorcycle accident involved alcohol consumption(4), and in 1996, also reported that 81.1 percent of injured patients caused by traffic accident had Blood Alcohol Concentration(BAC) over 80mg% and 68.25 percent had BAC over 100 mg%. (5) In 2004, Nakornratchasrima Hospital reported that 42.4 percent of severe injured patients caused by traffic accident had BAC over 40 mg%.(6)

According to the aforementioned reports, that alcohol drinking related to traffic accident which increasing legal limit of BAC was over 50 mg%.(7) as same as alcohol consumption that had related together. The volume of alcohol consumption has double increased from 20.2 liter/person/year in 1988 to 41.6 liter/person/year in 2001. (8)

The enforcement of BAC detection to examine impaired drunk driver have three methods - Blood test, Urine test, and Breath test. Testing Blood and Urine are

not normally carried out because both of them are expensive, and collecting the specimens for testing are more complicated.(9) So, police will usually conduct breath test to detect BAC at the checkpoint. However, Breath test was not sufficiently carried out because of expensive cost as the materials have to be imported from the USA and UK, thus, resulted in the Police lacking enough breath test for screening on drivers who are driving under alcohol influences.

In the USA, the Standard Field Sobriety Test (SFST) is the battery test which could detect drunk driver. Comparing to breast test, SFST is easier to use with simple materials. It is very effective as well as breath analyzer test in vary environment and weather conditions. (10)

Application of SFST began since 1977 by Burns and Herbert Moskowitz who was sponsored and funded by the National Highway Traffic Safety Administration, USA. The SFST is a three component tests consisted of Horizontal Gaze Nystagmus (HGN) (test involves following an object moving horizontally 12 to15 inches in front of the face), One Leg Stand (OLS) (test involves standing on one leg while counting 1 to 30 by thousands) and Walk and Turn (WAT) (test involves walking a straight line taking 9 steps up and 9 steps back, counting steps out loud).(11) Since, 1977 until the recent year, SFST was successfully developed and accepted to use like a standard drunk driver detecting and was used to classify the drunk driver who had BAC over legal limit.

SFST could be developed to use widely in many countries but it is mostly used for Caucasians more than Asians. All of studies had a few Asian who have different alcohol consumption behaviors, (12) as well as metabolism function from Caucasians. (13)

The SFST becomes more interesting to use because of its potential to classify the intoxication and it’s very beneficial for a developing country like Thailand. The purposes of this study are to estimate the possibility of using SFST with alcohol consumption in Thai people and study the validity of this method compare with breath analyzer test.

1.2 RESEARCH OBJECTIVE

To study the validity of the standard field sobriety tests (SFST) compare with breath analyzer test to determine alcohol intoxication in a sample.

1.3 RESEARCH HYPOTHESES

Validity of the standard field sobriety tests are the same as breath analyzer test when determining alcohol intoxication.

1.4 SCOPE OF RESEARCH

The subjects in this study are 20 - 40 year-old healthy volunteers staying in Buriram province. All volunteers have signed the consent form to participate in this study. They are requested to drink alcohol beverages and detect intoxication by using Standard field sobriety tests and breath analyzer test.

1.5 DEFINITION OF TERMS

1. Alcohol Beverages are defined as beer (usually contains about 5% to 8% of alcohol). The data from a survey found that the majority of the people who live in Buriram favorite beer Thai drinking**.** In this study alcohol beverage refer to Thai beer contains ethanol 6.3 % v/v, 330 ml/can. To prevent the subjects from being drunk, affected the BAC do not higher than 100 mg%, that is approximately two cans of beer which are being calculated by widmark's formula as following

$$b = \frac{a * 100}{c * d}$$

b = Blood alcohol concentration

a = amount of alcohol consumption (gram)

c = body weight

d = coefficient value (male = 0.7, female = 0.6)

2. Breath alcohol concentration (BrAC) means the percentage of alcohol in blood which measured by breath analyzer test that readout which value is mg%.

3. History of alcohol consumption are three components which including

3.1 Duration of alcohol intake (year)

3.2 Frequency of alcohol intake - person who has drunk alcohol beverage per week (day).

3.3 Quantity of alcohol intake - amount of alcohol intake per week (gram per week) (14)

6. EXPECED OUTCOMES AND BENEFITS

1. SFST can be applied detecting method to classify the drunk driver.

2. SFST can reduce the budget of purchasing comparing to purchasing breath analyzer test.

3. If SFST is used wider than breath analyzer, it can screen drunk drivers on the road to minimize chance of accident occurrence.

CHAPTER II
LITERATURE REVIEW

This chapter of literature review consists of four major parts. 1.Basic knowledge of alcohol including alcohol metabolism, individual differences in alcohol metabolism, removing from circulation**,** effect of alcohol on brain and the nervous system**,** definitions of levels of drinking, alcohol and accident, and alcoholic beverage consumption**.** 2. Law enforcement of alcohol intoxication. Finally, about method of detection alcohol intoxication include standards field sobriety tests (SFST) and breath test.

1. ALCOHOL

Alcohol is a compound composed of Carbon (C) Hydrogen (H) and OH (Hydroxy group) If it contains a single carbon, it is called Methyl Alcohol (CH_3-OH) use for cleaning wound. It contains two carbons, it is called Ethyl Alcohol (C_2H_5-OH) which is drinkable. Ethyl alcohol is commonly known as “liquor”

Alcohol Metabolism

Since the body can not store potential harmful alcohol, so it works extra hard to get rid f it. To prevent alcohol from accumulating and destroying cells and organs, the body quickly metabolizes alcohol before other compounds and has alternative pathways to handle excessive consumption.

Individual Differences in Alcohol Metabolism

Individual are varied in their ability to metabolize alcohol and acetaldehyde, and thus, differ in their susceptibility to inebriation, to hangover, and in the long term, to addiction and organ damage. The result of individual differences is easiest to observe in acute responses to alcohol. For example, when people of Asian descent drink alcohol, about half of them experiences flushing around the face and neck. This is probably a result of high blood acetaldehyde levels. These individuals lack gastric alcohol dehydrogenase and have an inefficient form of hepatic aldehyde dehydrogenase. This may explain why their ancestors depended on boiled water (for

tea) as a source of safe fluid. On the contrary, Europeans are able to metabolize larger quantity of alcohol, and historically, have relied on fermentation to produce fluids that were safer to drink. Elderly people often find their tolerance for alcohol is less than it used to be. Due to decreased tolerance, the effect of alcohol, such as impaired coordination, occur at lower intakes in the elderly than in young people whose tolerance increases with increasing alcoholic consumption. This reduction of tolerance is compounded by age-related decrease in body water, so that blood alcohol concentrations in blood of elderly people are likely to rise higher after drinking. Men and women also respond differently to alcohol. Blood alcohol rises faster in women, so they become more intoxication than men at an equivalent dose of alcohol intake. Accordingly, moderate drinking is usually defined as "two standard drinks for men and one for women." Women also metabolize alcohol more slowly than men. Various factors are attributed for alcohol's greater effect in women. Body size and composition is one. Women on average are smaller than men and have smaller livers, and therefore have less capacity for metabolizing alcohol. Women also have lower total body water and higher body fat than men of comparable size. After alcohol is consumed, it diffuses uniformly into all body water, both inside and outside cells. Because of their smaller quantity of body water, after drinking equivalent amounts of alcohol, women have higher concentrations of alcohol in their blood than men. Less enzyme activity is also another factor. For non-alcoholic, alcohol dehydrogenase (the primary enzyme involved in the metabolism of alcohol) is 40 percent less active in the stomachs of women than of men. This contributes to higher blood alcohol concentrations and lengthens the time needed to metabolize and eliminate alcohol. Chronic alcohol abuse--this exacts a greater physical toll on women than on men. (15, 16) Female alcoholics have death rates 50 to 100 percent higher than those of male alcoholics. Further, a greater percentage of female alcoholics die from suicides, alcohol-related accidents, circulatory disorders, and cirrhosis of the liver.

Removing Alcohol from Circulation

Despite its multiple alcohol-processing pathways, the liver can metabolize only a certain amount of alcohol per hour, regardless of the amount in the bloodstream. The rate of alcohol metabolism was depend on several factors, including the amount of metabolizing enzymes in the liver, and varies greatly between the

individual. In general, after one standard drink, the amount of alcohol in blood of drinker (blood alcohol concentration, or BAC) reaches peak level in 30 to 45 minutes. When absorption exceeds the liver's capacity, a bottleneck is created and alcohol enters the systemic circulation. Alcohol diffuses rapidly, dispersing equally into all body fluids, including cerebrospinal fluid and the brain and, during pregnancy, into the placenta and lungs, and through skin. Consequently, urine tests and breath analyzer tests both reflect concentrations of blood alcohol as well as alcohol levels in the brain, and can indicate how much a person's mental and motor functions may be impaired. Excessive alcohol consumption deprives the brain from oxygen. The struggle to deal with an overdose of alcohol and lack of oxygen eventually causes the brain to shut down functions that regulate breathing and heart rate. This shutdown leads to a loss of consciousness and in some cases coma and death. When a drinker passes out, the body is actually protecting itself when someone loose consciousness, they can't add more alcohol to their system. If people consume such a large quantity of alcohol in short period of time that the brain of the victim was overwhelmed (called alcohol poisoning death). Heart and lung functions shut down and the person died.

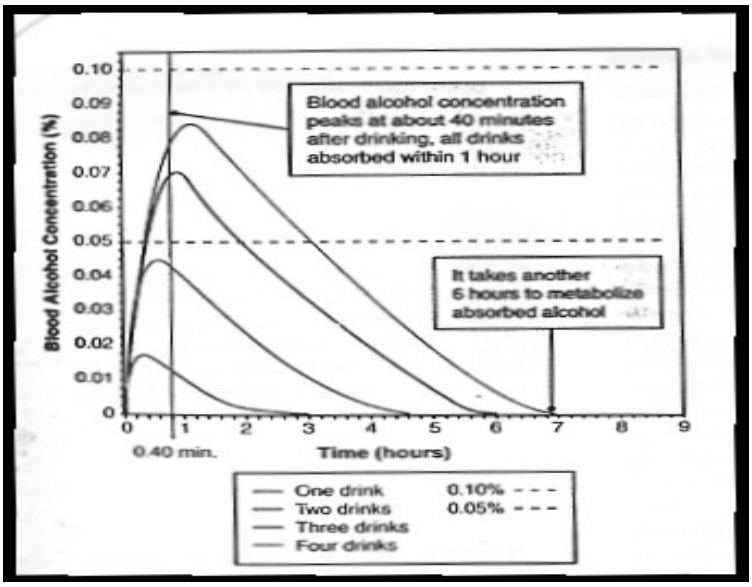

Figure 1 Blood alcohol concentration over time

Source: National Institute on Alcohol Abuse and Alcoholism. Alcohol Alert No.35.PH371; January 1997.

Alcohol in Brain and Nervous System

Alcohol diffuses rapidly into brain, and because a small amount is absorbed directly from the mouth into blood circulation, its effects can be almost immediate, reaching the brain in as little as one minute after consumption.

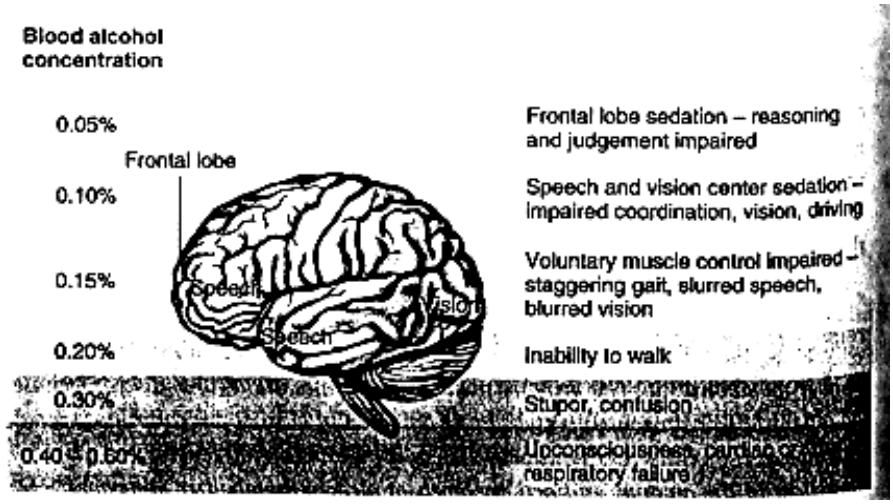

Figure 2 Effects of alcohol on the brain. As blood alcohol concentration rises, different parts of the brain are affected.

Source: American Dietetic Association, Nutrition 2002

Because alcohol is fat soluble, it can easily cross the protective fatty membrane of nerve cells. Therefore, it disrupts the brain's complex system in communicating between nerve cells. Neurotransmitters that excite nerve cells and those that inhibit nerve cells are thrown out of balance. Excessive neurotransmitters cause sleepiness; high levels of other cause a loss of coordination, an imbalance of other impairs judgments and mental ability. There are still other neurotransmitters perpetuate the desire to keep drinking, even when it's clearly time to stop. Changes in these messengers are suspected of leading to addition and symptoms of alcohol withdrawal. In a short time, they probably contribute to a hangover. Alcohol's short-term effect are dose related. One or two drink typically bring alcohol blood levels to

0.04 percent and usually cause only mild, pleasant changes in mood and release of inhibitions. With more drinks and rising blood alcohol levels, coordination, judgments, reaction time, and vision are increasingly impaired. In some states and Canadian provinces, it is illegal for a person whose blood level of alcohol has reached or exceeds 0.08 percent to drive a motor vehicle.

Table 1 Alcohol impairment chart in MEN

Approximate Blood Alcohol Percentage									
Drinks	Body Weight in Pounds								
0	100	120	140	160	180	200	220	240	Only safe driving limit
1	**0.04**	0.03	0.03	0.02	0.02	0.02	0.02	0.02	Impairment Begins
2	0.08	**0.06**	**0.05**	**0.05**	**0.04**	**0.04**	0.03	0.03	**Driving Skills Significantly Affected**
3	0.11	0.09	0.08	**0.07**	**0.06**	**0.06**	**0.05**	**0.05**	
4	0.15	0.12	0.11	0.09	0.08	0.08	**0.07**	**0.06**	**Possible Criminal Penalties**
5	0.19	0.16	0.13	0.12	0.11	0.09	0.09	0.08	
6	0.23	0.19	0.16	0.14	0.13	0.11	0.10	0.09	
7	0.26	0.22	0.19	0.16	0.15	0.13	0.12	0.11	Legally Intoxicated
8	0.30	0.25	0.21	0.19	0.17	0.15	0.14	0.13	
9	0.34	0.28	0.24	0.21	0.19	0.17	0.15	0.14	Criminal Penalties
10	0.38	0.31	0.27	0.23	0.21	0.19	0.17	0.16	
One drink is 1.5 oz. of 80 proof liquor, 12 oz. of beer, or 5 oz. of table wine									

Subtract .01% for each 40 minutes of drinking

Table 2 Alcohol Impairment Chart in Women

Approximate Blood Alcohol Percentage										
Drinks	Body Weight in Pounds									
0	90	100	120	140	160	180	200	220	240	Only safe driving limit
1	**0.05**	**.05**	**.04**	.03	.03	.03	.02	.02	.02	Impairment Begins
2	0.10	0.09	0.08	**0.07**	**0.06**	**0.05**	**0.05**	**0.04**	**0.04**	**Driving Skills Significantly Affected Possible Criminal Penalties**
3	0.15	0.14	0.11	0.10	0.09	0.08	**0.07**	**0.06**	**0.06**	
4	0.20	0.18	0.15	0.13	0.11	0.10	0.09	0.08	0.08	
5	0.25	0.23	0.19	0.16	0.14	0.13	0.11	0.10	0.09	
6	0.30	0.27	0.23	0.19	0.17	0.15	0.14	0.12	0.11	Legally Intoxicated
7	0.35	0.32	0.27	0.23	0.20	0.18	0.16	0.14	0.13	
8	0.40	0.36	0.30	0.26	0.23	0.20	0.18	0.17	0.15	
9	0.45	0.41	0.34	0.29	0.26	0.23	0.20	0.19	0.17	
10	0.51	0.45	0.38	0.32	0.28	0.25	0.23	0.21	0.19	Criminal Penalties
One drink is 1.5 oz. of 80 proof liquor, 12 oz. of beer, or 5 oz. of table wine.										

Source: The National Clearinghouse for Alcohol & Drug Information Pennsylvania Liquor Control Board Alcohol Impairment Chart (revised 062304)

Definitions of levels of drinking

Term	**Criterion**
Moderate drinking (NIAAA)	Men: ≤ 2 drinks per day
	Women: ≤ 1 drink per day
	Over 65: ≤ 1 drink per day
At-risk drinking (NIAAA)	Men: > 14 drinks per week or > 4 drinks per occasion
	Women: >7 drinks per week or > 3 drinks per occasion

Alcohol abuse (APA) Maladaptive pattern of alcohol use leading to clinically significant impairment or distress, manifested within a 12-month period by one or more of the following:

- Failure to fulfill role obligations at work, school, or home
- Recurrent use in hazardous situations.
- Legal problems related to alcohol.
- Continued using despite alcohol-related social or interpersonal problems.
- Symptoms have never met criteria for alcohol dependence.

Alcohol dependence (APA) Maladaptive pattern of alcohol use leading to clinically significant impairment or distress, manifested within a 12-month period by three or more of the following:

- Tolerance (either increasing amounts used or diminished effects with the same amounts).
- Withdrawal (withdrawal symptom or use to relieve or avoid symptoms).
- Use of large amounts over a longer period than intended.
- Persistent desire or unsuccessful attempts to cut down or control use.
- Great deal of time spent obtaining or using or recovering from use.
- Important social, occupational, or recreational activities given up or reduce
- Use despite knowledge of alcohol-related physical or psychological problems.

Hazardous use (WHO) Person at risk for adverse consequences.

Harmful use (WHO) Use resulting in physical or psychological harm

Note: NIAAA = National Institute on Alcohol Abuse and Alcoholism
APA = American Psychiatric Association
WHO = World Health Organization

Source: O'connor PG, Schottenfeld RS, Patients with alcohol problems. N Engl J Med. (15)

Alcohol and Accident

Accident was the second important health problem in Thailand. Death rate was approximately 50 per 100,000 persons during 1997 to 2003. The mortality rate had declined to the lowest at 35.5 per 100,000 persons in 1998. On contrary, it had climbed to the highest at 56.1 per 100,000 persons in 2003. This has become a big problem which required the prevention and treatment to ensure the life safety.(17)

Traffic accident is the most causes of accident and the trend of mortality rate were varied during 1987-2002. It increased from 22 per 100,000 persons in 1993 to 28 per 100,000 persons in 1996, then decreased to the lowest rate of 12.8 per 100,000 persons in 1998, but the trend was continued increasing. Approximate 50 percent of severe injury patients was detected of having drink alcohol. Male had mortality rate more than female approximately 4:1 in every year. Lowest mortality rate was recorded in 1987, and highest in 1995. Ages between 15 to 29 years had the highest mortality rate every year. (3) The mortality rate in young and elder groups was lower than worker group. It was extreme mortality rate occurred 20 to 24 years. Early month had more mortality rate than the other month. Festive seasons in January, Songkran Festival celebration and long weekend or long holidays are times when the highest mortality rate is recorded.

Alcoholic Beverage Consumption

Thai people trends to consume more alcoholic beverages. In the past decade, alcohol use rose from 721.8 million liters in 1988 to 1,604.3 million liters in 1997 or about double increase. After the economic crisis, alcohol consumption had a declining trend from 1,689.8 million liters in 1998 to 1,340.9 million liters in 1999. However, in 2001, alcohol consumption increased again to 1,926.1 million liters. Regarding alcohol beverage category, liquor consumption among Thai people is relatively stable. While beers and wines consumption are inclined to increase due to the implementation of free-trade policy by Government in 1992 which enable the establishment of several beer and wine factories. Market competition, product advertisement and cheaper sell price introduced by the manufacturers made beers and wines drinking popular.

Alcohol consumption of Thai people by person is also on the increasing trend. During 1998 to 2001, volume of alcohol consumption was double increased

from 20.2 liter/person/year in 1988 to 41.6 liter/person/year in 2001 and it is still increasing.

Table 3 Concentration of alcohol by trade name of alcohol beverage in Thailand

Type of alcohol beverage	Trade name	Alcohol % vol. (degree)
1. Beer	Chang	6.5
	Leo	5.0
	Singha	6.0
2. Wine		14
3. Liquor	Maekhong	35
	Hongthong, Hongthai	35
	Sangshom	40
	Regency	38
	Chivas	43
4. Local liquor (home product)		35

2. Law enforcement of alcohol intoxication

In Thailand had used the law of traffic since 1979 and was edited to law enforcement for detect amount alcohol intoxication in driver and labeled method to determine in 1994. Detection method tested drunk driver to determine blood alcohol level. The method includes breath analyzer is display the value in milligram percent, urine test and blood test. If intoxication indication is over 50 mg% BAC, that drunk driver will be arrested. (18)

3. Method of detection alcohol intoxication

3.1 Standard Field Sobriety Tests

The Standard Field Sobriety Tests is widely used to detect drunk driver in U.S.A. It is simple and easy to use, effective, no complicated materials, and can be used in various conditions. SFST was sponsored and funded by the National Highway Traffic Safety Administration. It was launched began before1977 by Marcelline Burns

and Herbert Moskowitz as part of DWI arresting procedures, test of alcohol impairment may be used by police offices, either at roadside or in the station . It was call ‘Psychophysical Tests for DWI Arrest’. The objective of this study included evaluation of currently-used test, development of more sensitive and reliable measure, and the standardization of test administration. Criteria for the selection of sobriety tests and an initial list of potential tests were derived from field observation, interviews with law enforcement officers and from literature review. Administration and scoring procedures were standardized during laboratory pilot studies of the tests. On the basis of preliminary investigation, six tests were chosen for an evaluation study. They were One-leg-stand, Walk and turn, Finger to Nose, Finger Count, Alcohol Gaze Nystagmus (AGN), Tracing, and alternate tests (Romberg body sway, Subtraction, Counting Backward, Letter Cancellation).

Ten officers administration the six tests battery to 238 participants who were light, moderate and heavy drinkers. They had BACs in the range 0 to 0.15 %. The polices score the performance of each test on a 1-10 scale, and on the basis of the entire battery judged whether the person should be arrested or released, assuming a legal criterion of 0.10 %BAC.

All of the 6 tests were found to be alcohol sensitive, and the officers made correct arrest/release decision for 76 percent of the participants. Data analysis led to recommendations of a ‘best’ reduce battery of tests which includes examination of balance (One Leg Stand and walking (Walk and Turn), as well as the jerking nystagmus movement of the eyes (Alcohol Gaze Nystagmus). The sobriety test battery can be administered without special equipment in most roadside environments, and it can be adapted to yield more precise measurement if administered in the station. The total test time in most cases will be no more than five minutes, more than 83 percent of the evaluation study participants can be correctly classified on the basis of just three tests. This study suggested that a more appropriate legal BAC limit should be reduced from 0.10% to 0.08%.(12)

The SFST was successfully developed by many experts which made administration and scoring more simple to used with more effectiveness. The standard field sobriety test includes three tests. There are

3.1.1 Horizontal Gaze Nystagmus

The test is imperative that the suspect's eye be able to follow the stimulus in front of the eye which moves side to side on horizontal level. It is involuntary jerking of eyes. In intoxication indicate three signs will be observed. Each eye must be checked separately. With only four exceptions, the maximum score of six HGN signs was recorded for arrested drivers whose BAC's subsequently were found to be 0.05% and above.

Instruments; Penlight or pen

Place; Quiet background, away from the moving objects so as to avoid the probability of evaluating an induced condition, away from the viewing of passing motorists, and certain environmental factors without wind and dust.

Condition and Limitation of test;

1. Eyeglasses are to be removed. If the suspect cannot see the stimulus after removing the eyeglasses they must be allowed to perform it with them on.

2. Hard contact lenses are to be removed so as to avoid dislodging when the eyes are out at maximum deviation or to prevent damage to the eyes.

3. A person with a glass eye or only visualize with one eye can not be given this test. An evaluation of just one eye and double the score by assuming the other eye will give the same results is both erroneous and improper.

5. If the suspect has what is known as the lazy eye condition, the officer is trained to test one eye while the other eye is covered by the suspect's hand, then, switch side

6. A person who is color blinded is not valid for this test as they will probably have a pathological Nystagmus which is normal, and natural for that person. Three to four percent of the general population will exhibit a pathological Nystagmus. This can be caused by some type of neurological disorder, brain damage, epilepsy or pathological disorder which the suspect was born with or of unknown etiology. A large disparity between the right and left eye can clue the officer into this problem. At an accident scene, if the suspect sustains a concussion, this may bring on a pathological Nystagmus there by invalidating this test.

Performance and Scoring of test

The suspects; They must be instructed to look straight ahead, keeping the head still while following and focusing on the stimulant with the eyes until being told to stop. If the suspect moves his head to the side at any time, the score may be invalid regardless of which clue we are looking for.

The observers; The observer holds the stimulus twelve to fifteen inches in front of the suspect's eyes for ease of focus. The stimulus should be held above eye level, so that the eyes are wide open when they look directly at it. Due to narrowness of certain individual's eyes, it becomes more difficult to make a fair evaluation of the Nystagmus unless the eyes are wide open. If the observer believes that the Nystagmus might be there, it can not be scored, as the benefit of the doubt must be given to the person that is being tested.

Indicators to decide intoxication

The examination for three signs in each eye yields a possible total score of six. The three signs are:

1. **Lack of smooth pursuit**

The eyes do not smoothly pursue the moving stimulus but instead move in a jerky manner. The suspect's inability to pursue a moving stimulus smoothly while focusing the stimulus being moved horizontally from side to side. If the suspect is under the alcohol influence, the eyes will bounce or jerk.

The observer is instructed to check the left eye first by moving the stimilus to the officer's right hand. The stilmulus must be moved smoothly, at a speed of about two seconds, to bring the suspect's eye as far to the side as it can go. Any choppy or shaky hand movements or movement that is too fast by the observer may induce a Nystagmus in the suspect's eyes and invalidate the scoring and test. The observer is instructed to make two or more passes in front of the eye to be absolutely certain that what they are seeing is Nystagmus and a valid clue. If this clue is scored as Nystagmus the suspect is assessed one point.

If the suspect has this clue emanating in one eye, it is no guarantee that it will be exhibited in the other eye. This should be the easiest clue to see.

After they have checked the first eye for the smooth pursuit clue, they must check the same eye for what is called distinct jerkiness at maximum deviation.

Figure 3 Demonstration of lacking smooth pursuit

2. Nystagmus at maximum deviation

A distinct jerking occurs when the eyes are deviated as far as possible in the horizontal plane. This is accomplished by simply moving the stimulus to the side until the eye has gone to the side as far as possible. At maximum deviation, no sclera or white will be showing at the corner of the eyeball. The observer must hold the eyeball at that position for two or three seconds, and observe the eyeball for distinct jerkiness. The jerkiness must be both distinct and obvious.

If the observer can not see this distinction from a slight nystagmus, the benefit of doubt must be given to the suspect. The observer may make the mistake of not inducing the eyes to the side as far as they can go or too rapidly return the stimulus and incorrectly score this part of the test. The criteria of no white showing at the corner of the eye must be met. A nystagmus may be incorrectly mistaken for physiological nystagmus if the observer does not hold the stimulus to the side for two or three seconds.

Approximately 50% of the suspects undergoing the testing, a physiological Nystagmus will be apparent when the eye initially arrives at maximum deviation. This is due to a person not normally following the stimulus all the way to the side with their eyes, but turning their head to view that stimulus. Consequently, a certain degree of uncomfortable is experienced, causing a slight twitching of the eyes at this location. If the observer brings the eyes out to the side and then immediately brings them back, he may be scoring this physiological nystagmus inappropriately.

Everyone has a physiological nystagmus, but it is not visible to the naked eye. The reason it exists is to exercise the eye muscles, lubricate them, and prevent atrophy. Remember the jerkiness must be distinct and obvious to be scored a point.

Figure 4 Demonstration of nystagmus at maximum deviation

3. Onset of the jerking movement prior to 45 degrees

Nystagmus occurs and persists at an angle of gaze less than 45 degrees. This is the most difficult to evaluate. If a suspect exhibits this clue in one eye, the probability increases that all the other clues will be seen as well. This does not work in reverse though. If a suspect has any of the first two clues, it is no guarantee that the third clue will be observed. Because the 45-degree angle is a key factor in assessing the degree of alcohol influence in a suspect. So, it is important to know how to estimate that angle.

In the manual and demonstration of this by the State Police instructor, an eight inch square template is shown to the students to assist them in estimating this angle, but it is rarely, if at all, used by the student or the instructor other than merely pointing out its existence. Even though this is the case, if used, this devise must be held up so that the suspect's nose is above the diagonal line. One edge of the template is centered on the nose and perpendicular to or at right angles to the face. The person is told to follow the stimulus until they are looking down the 45-degree diagonal. This

obviously is used as practice to recognize the angle. A rule of thumb that is being taught is in order to estimate the 45-degree angles, the stimulus must be halfway between the suspect's ear and nose on the side being tested or just outside the shoulder area.

The estimation of this angle is critical. Since studies have shown that as the alcohol increases, the angle will decrease. Although this may be the case, this angle should not be used to estimate a specific amount of alcohol in the bloodstream. In order to properly score this part of the test, the officer must move the object to the 45-degree angle of gaze, holding about four seconds. As the eye follows the stimulus looked for the jerking. If nystagmus is observed, stop the stimulus and the officer must make observation if it is continuing at this point. If it continues, then, the officer must make sure that there is still white showing at the corner of the eye, and the angle must be estimated to be less than 45-degrees. If it does not, continue to move the stimulus until the jerking occurred. Continues the movement or until the 45-degree angle is reached. If no white of the eye is showing, the eye has either been taken too far to the right, which would be maximum deviation that is being evaluated, or the person has unusual eyes that will not deviate very far to the side. The criterion of onset before 45-degrees can only be used if some white can be seen at the outer part of the eye. Too often, the observer incorrectly estimates the angle or scores this with no white showing at the corner of the eye or both.

Figure 5 Demonstration of onset of the jerking movement prior to 45 degrees angle

This test is deemed the most reliable test in determining probable cause to believe someone is under the influence of an alcoholic beverage. This depends on the proper administration, proper scoring, and proper training

A score of four points out of possible six after the scores of each eye are added up, the observer is instructed to decide if the suspect violates driving law. This test should be carried out while the suspect is standing or sitting correctly. It is not appropriate if the suspect is in a supine position. At an accident scene, with suspect lying down and this test performed, it would be invalid due to positional alcohol Nystagmus being the cause of the Nystagmus encountered. This is a vestibule type of Nystagmus that is evident when the amount of alcohol in the vestibule system is in unequal proportions to the amount of alcohol in the bloodstream and reacts to gravity such as the changing position of the head.

3.1.2 Walk and Turn Test

The Walk and Turn test is an objective test based upon certain predictable errors that a person under the influence will display, as well as scoring factors that will give the tester a basis for passing and failing other than their subjective opinion.

The test was called ‘Divided Attention Test’ which divides the suspect's attention between mental and physical tasks. The physical tasks include balance and coordination while the mental tasks include comprehension of verbal instructions, processing of information and recall of memory. While a person may be able to perform one task they may not be able to perform the other if under the influence of an alcoholic beverage.

Place: It is required that Walk and Turn Test be performed on a hard, dry, level, non-slipping surface with sufficient room for the suspect to complete nine heel-to-toe steps. This test loses some validity when conducted in certain wind/weather conditions that counters this criterion. The manual calls for a straight line, which must be clearly visible on the surface but in the DWI course it is taught that the test can be performed parallel to the curb. Conditions must be such that the suspect would be in no danger if he or she were to fall**.**

Condition and Limitation of test

1. Individuals wearing high-heeled shoes more than two inches should be given the opportunity to remove their shoes as this may diminish the validity of the results.

2. Performing this test to person over sixty five years old or weighting over fifty pounds, having physical impairment that would affect body balancing is exception. Individuals who can not see out of one eye may also have trouble with this test because of poor depth perception and should not be given this test.

Performance and Scoring of test

The suspect: A suspect is given detailed, standardized instructions for walking nine heel-to-toe steps along a line, turning, and returning along the line with nine heel-to-toe steps. A WAT score reflects an individual's ability to attend to and remember very specific instructions as well as to maintaining balance and walk.

The observer: The observer must observe the suspect from three or four feet away and remain motionless while the suspect performs the test. Being too close or excessive motion may cause the suspect to make errors they might not have committed otherwise. This will cause some validity of the results to be lost as even a sober person may have difficulty under these conditions.

The observer must give good verbal instructions and accompany this by demonstrations when having the suspect perform this test. They must make sure that the suspect understands the instructions and are trained to receive an acknowledgement of same and to document that affirmative response.

Indicators to decide intoxication

This test is scored in relation to eight scoring factors that can be seen in two separate stages.

1. Instruction Stage

The observer must verbally tell the suspect to assume the heel to toe stance and must demonstrate this. The suspect is told to place their left foot on the line and place their right foot on the line ahead of the left foot, with heel of right foot against toe of left foot, look down at their feet while performing this stage of the test and to count their steps out loud. This must be demonstrated because without demonstration and using instructions alone decreases the tests validity. The observer is instructed by

way of training to ensure the right foot is in front of the left foot at the start so to maintain uniformity of this test. This also becomes important later in the test during the turning evaluation. If the suspect is instructed or demonstrated improperly, it may affect the suspect during this part of the test. After obtaining the correct starting position, the observer must inform the suspect to remain in that position until they are told to start walking. The observer must ensure the suspect understands this. If the observer does not reiterate the question to check understanding or receiving an affirmative response, the test may not be scored fairly and properly, thereby invalidating the results.

There are two ways that the officer, if the procedures have been abided by that the observer can assess a point to the suspect's performance.

1.1 Lossing balance during instructions; If the suspect cannot keep balance while listening to the instructions, a point is scored. This item is only scored if the suspect does not maintain the heel to toe position throughout the instructions. The observer is trained to be conservative in their scoring and not to score a point if the suspect sways or uses the arms to help balancing self, but maintains the starting position during this stage. The observer must demonstrate two or three heel to toe steps for the suspect. The observer then informs the suspect and demonstrates the same, that when the turn is performed, the suspect must keep the foot on the line, and turn by taking a series of small steps. If the observer demonstrates or instructs wrong foot at the beginning, the way a suspect turns will be affected also. The observer then continues with informing the suspect to keep their arms at their sides while walking, watch their feet at all times, and to count their steps out loud. They must be told that they can not stop once they start walking.

1.2 Starts before instructions are finished; a second scoring factor is known as starting too soon. This is given when the suspect starts to walk before the officer instructs them. This can only be scored if the observer specifically instructed the suspect not to start until being told and the suspect stated they understood this instruction.

2. Walking Stage

The observer is to explain the test requirements, using verbal instructions and accompanied by demonstrations. The suspect is told again when to start. They must take nine heel to toe steps, turn around, and take nine heel to toe steps back.

There are six scoring factors that can be observed in this stage.

1. Stops while walking; the observer can not score this item if the suspect is merely walking too slowly. The suspect must pause for several seconds after one step. If this occurs, the observer is trained to request the suspect to repeat at that difficult point instead of starting over again as this test looses sensitivity if it is repeated several times.

2. **Do not touching heel to toe:** This can be very subjective unfortunately. If the suspect leaves a one half inch or more between the heel and toe or does not walk straight along the line, they can only be assessed one point-no matter how many times this occurred.

3. **Steps off the line: T**his means that one of the feet must be entirely off the line and not merely diagonal. Even if the suspect steps off twice, they are only given one point.

4. **Sways or using arms to balance**; The suspect raises one or both arms more than six inches from the side in order to maintain balance. If this is noticed to be the normal position of the arms, as in some body builders, the observer is trained to take that into account and be conservative in their scoring. Any benefit of doubt must be given to the suspect.

5. **Loss balance while turning:** This item can only be scored if the suspect removes both feet from the line while turning or does not take several small steps, and pivots in one movement as in an about face movement. It is imperative that the observer has demonstrated and articulated this movement properly in order to be scored correctly. It is important that the observer be conservative in their evaluation of this turn and not be overly critical.

6. **Take the incorrect number of steps:** This item is scored only once, even if the incorrect number of steps are taken in either direction. The suspect was instructed to look down at their feet while performing this stage of the test and to count their

steps out loud. But if they don't adhere to these instructions, they can not score a point as these are not one of the scoring factors.

There are two ways that the suspect can receive a maximum of eight points on this test. If they step off the line three times or more or they can not do the test. If they can not do the test, it must be explained by the officer.

If the suspect receives two total points on this test, the observer is trained to use this as probable cause to believe that the suspect is under the influence of an alcoholic beverage.

Figure 6 Demonstration of walk and turn test

3.1.3 One Leg Stand Test (OLS)

This test was to maintain balance self with one leg stand and counting by thousand for 30 seconds. The test called 'Divide Attention test'.

Place: It must be performed on a hard, dry, level, non-slippery surface. Conditions must be such that the suspect would be in no danger if he or she were to fall. Certain wind/weather conditions obviously may interfere with and affect the validity of this test. There must be adequate lighting to perform it. In total darkness, even the average, sober person may have difficulty with this test, due to their visual frame of reference being taken away.

Condition and Limitation of test

1. Individuals wearing high heeled shoes higher than two inches should be given the opportunity to remove their shoes as this may diminish the validity of the results.

2. Performing this test to person over sixty five years old or weighting over fifty pounds, having physical impairment that would affect body balancing is exception. Individuals who can not see out of one eye may also have trouble with this test because of poor depth perception and should not be given this test.

The suspect: The suspect is given detailed, standardized instructions to stand with one leg

The observers: The test is imperative that the tester observe the DWI suspect from at least three feet away, and remain as motionless as possible while the suspect is performing this test. If this is not done, the test may be interfered with and ultimately affect the results and validity. The observer giving verbal instructions and demonstrate this test to suspect which must receive an indication.

Performance and Scoring of test: In the administration of this DWI test, there is also two separate stages involved;

1. The Instruction Stage

The test is initiated by giving verbal instructions, followed and accompanied by demonstrations of those instructions. The observer is trained to advise the suspect to stand with their heels together and arms down at their sides. The observer must also inform the suspect not to start the test until being told. The observer must receive an indication from the suspect that they understand the instructions and document their

acknowledgement. There are no scoring factors involved until the suspect move into the next stage.

2. The Balance and Counting Stage

The observer is required to explain the testing requirements further by instructing the suspect to stand on one leg, putting the other foot in front while the observer is demonstrating. The suspect should be allowed to stand on either leg that they wish. The suspect is instructed to keep the foot raised about six inches off the ground. The observer demonstrates this and should advise the suspect if the observer id not satisfied. The suspect is further instructed that while they are standing, they will count out loud for 30 seconds, and the tester will demonstrate the count as "one thousandth and one, " one thousandth and two', etc., all the way to thirty-one thousandth. The suspect is told to look down at their foot while counting and throughout the entire test, to keep their arms at the sides at all times. They are told to refrain from hopping or swaying while standing. The suspect must again acknowledge that they understand the instruction to retain validity of the test. The test is then begun.

A suspect may score a point for the following reasons.

1. **Sways while balancing**; the observer is trained not to be too critical in this scoring as the suspect is a living, breathing person, and some sway will be noticed as a result of this. The swaying that can be scored is a marked sway, such as a back-and-forth motion while the suspect maintains the one-leg-stand position.
2. **Using arms to balance**; Suspect should put their arms six or more inches from the side of the body. Again it must be taken into account the distance of arms from the body that the suspect normally starts with such as in the case of bodybuilders.
3. **Put their foot down**: Regardless of how many times, they are only given one point on this scoring factor. The suspect should be allowed to repeat the difficult point in stead of starting over again if it fails in the mid of the testing as this test may lose sensitivity if repeated several times. The suspect has been instructed to keep watching their raised foot and to count out loud. But if they do not follow either of these instructions, they are not scored any points as it is not a part of any scoring factor. If the suspect counts too slowly, it is imperative that the

observer stop the test after thirty seconds have elapsed as this may affect the scoring and validity of the test. The observer is trained to time thirty seconds of total test time. If the suspect counts too fast, the observer must tell to slow down.

4. Hops on one foot: This is scored only if they resort to hopping on the anchor foot in order to maintain balance. It should not be scored if the suspect is having difficulty by moving the anchor foot back and forth. The observer is supposed to be able to distinguish this as part of their training and to allow the suspect this benefit.

The suspect can receive a maximum score on this test in two ways. Firstly, if the suspect puts their foot down three times or more during the thirty second count. And secondly, it is otherwise demonstrates that they can not do the test. The officer must be able to articulate why they felt the suspect could not do this test.

If the suspect receives two total points on this test, the observer is trained to use this as probable cause to believe that the suspect is under the influence of an alcoholic beverage. (19)

Figure 7 Demonstration of one leg stand test

The Standard Field Sobriety Tests have been widely used to detect drunk driver over legal limit in U.S.A. for more than thirty years ago. It began study before 1977 to assist the officer to decide whether to arrest or release alcohol impairment driver. The initial study included evaluation of currently-used test, development of more sensitive and reliable measure, and the standardization of test administration. Administration and scoring procedures were standardized during laboratory pilot studies of the tests. On the basis of preliminary investigation, six tests selected for an evaluation study were One-leg-stand, Walk and turn, Finger to Nose, Finger Count, Alcohol Gaze Nystagmus (AGN), Tracing, and alternate tests (Romberg body sway, Subtraction, Counting Backward, Letter Cancellation). Ten officers administration the six tests battery to 238 participants who were light, moderate and heavy drinkers. They had BACs in the range 0 to.15 %. The polices score the performance of each test on a 1-10 scale, and on the basis of the entire battery judged whether the person should be arrested or released, assuming a legal criterion of 0.10 %BAC. All of the 6 tests were found to be alcohol sensitive, and the officers made correct arrest/release decision for 76 percent of the participants. Data analysis led to recommendations of a 'best' reduce battery of tests which includes examination of balance (One Leg Stand and walking (Walk and Turn), as well as the jerking nystagmus movement of the eyes (Alcohol Gaze Nystagmus). The sobriety test battery can be administered without special equipment in most roadside environments, and it can be adapted to yield more precise measurement if administered in the station. The total test time in most cases will be no more than five minutes, more than 83 percent of the evaluation study participants can be correctly classified on the basis of just three tests. This study suggested that more appropriate BAC legal limit should be reduced from 0.10% to 0.08%.(11)

The many studies were development administration and scoring of SFST for simple used and more effectiveness. For example, a sobriety battery was standardized for effectiveness then evaluated in the laboratory and to a limited extent in the field. The result shown that the officers were able to classify 81 percent of 297 drunk volunteers, on the basis of their test scores, with respect to whether their BACs were above or below 0.10%. Officer estimates of the BACs of drinkers they tested differed by 0.03% on the average from the actual BAC. Inter rater and test-retest reliabilities

for the test battery range from 0.60 to 0.80.(14) It was confirmed again that the test can be easily and effectively used in the field and suggest that the gaze nystagmus test is the most powerful of the three.(15) The Florida law enforcement officers were repeated training under NHTSA guidelines to administer, score, and interpret the SFSTs, who have developed experience and skill with the SFSTs, who use only the 3-test battery to examine DUI drivers, and who do not have access to preliminary breath tester (PBT) will be equal to or greater than 90 percent correct, as confirmed by measured BACs. (21) The important study that evaluated the accuracy of the Standardized Field Sobriety Testing (SFST) Battery to assist officers in making arrest decisions for DWI at blood alcohol concentrations (BAC) which the trend to reduce statutory DWI limits below 0.10 percent to 0.08 percent. The results of this study provide clear evidence of the validity of the SFST battery to discriminate at 0.08 percent BAC, using a slightly modified scoring procedure. Furthermore, study results strongly suggested that the SFSTs also accurately discriminate at 0.04 BAC. (22) In addition to, assign officers' decisions and to examine the accuracy of the SFST battery when used in the widely varying weather conditions of Colorado winter, spring, and summer months. (10)

The application of SFST which was used in the marine environment That overall correlation of the officers' FST based estimation and BACs obtained from using breath analyzer test was approximately 0.70. This level is consistent with similarly obtained correlations from highway studies. (Sussman, 1990 #67) and it was adapted to detect marijuana intoxication in Australia which the result were correctly assessed 76.3% of participants in the high THC condition as either impaired or not impaired on driving, the correct identification of 84% of impaired drivers as impaired, but only 61.5% of unimpaired drivers as impaired, and the One Leg Stand test is the most sensitive, (23) as same as the evaluation trials for drug recognition and field impairment testing in London, United Kingdom.(24) It can used to the procedure for detection of drug impaired drivers, is a practical, effective and valid for police (25). The resulted of the accuracy was 73% of it for classification of the sample as either impaired or not impaired on the driving task after administration of cannabis (26). It was the partial to determine individual behaviorally impaired of drug

which can used to predict accurately acute administration by the drug evaluation and classification program. (27)

Table 4 Validity of STST during 1977 to 1998

Year	Sensitivity (%)	Accuracy (%)	BAC limited legal(%)
1977	54	76	0.10
1981	81		0.10
1983		80	0.10
1995	84		0.05
1997	95		0.08
1998	90	91	0.08
1998		94	0.04

In conclusion, the SFST had been developed for easy to use in varied weather conditions and is able to classify drunk driver, it was well acceptable by the police and also adaptable to in marine environment or detect marijuana intoxication. The gaze nystagmus test is the most powerful of the three tests. The most accuracy was 94 % when discriminate at 0.04 percent BAC. It confirmed that the trend to reduce statutory DWI limits should be below 0.10 percent BAC. The SFST is very effective as well as breath test and led to penalize for drunk driver who have over BAC legal limits.

3.2 Breath test

The rule of breath analyzer test is the suspect must breaths from deep lung into analyzer which is equipped with alcohol sensor inside. The sensor can change the position which is obviously seen. For example, change color chemical, measure energy and follow to a dial or readout which relation between alcohol in blood and breath with Blood: Breath ratio was 1: 2100.

Breath analyzers used in this study are Lion Alcometer (AlcoSensor IV). The AlcoSensor IV is a hand-held breath alcohol tester. It offers a simple, accurate and economical method of determining a subject's alcohol level in blood. The AlcoSensor

IV follows automated software driven test protocol. Each function is displayed on an LED panel which provides the operator with step-by-step instructions for fail-safe testing. The AlcoSensor IV automatically samples deep lung breath and show results in a three-digit display. The unit has automatic calibration and a mouthpiece release feature which eliminates operator contact with a used mouthpiece. The fuel cell sensor generates a response that is proportional to the Breath Alcohol Concentration. US DOT approved for evidential use. Meets and exceeds the federal model specification for traffic enforcement and Omnibus Breath Alcohol Testing. The fuel cell sensor is sensitive to alcohol. It does not respond to acetone or other substances which are found in the breath. The Alco Sensor III can accurately detect breath's alcohol levels between .000 - .400 BrAC. The unit responds within 10 seconds on negative samples and within 30 - 45 seconds on positive samples. The patented analytical system permits quick results, more positive tests per time period with no loss of sensitivity. Instruments will maintain calibration (plus or minus .005 at the .100 level) for months. Checks and calibrations should be performed with either a Thailand's Ministry of Public Health approved wet bath simulator or a dry gas standard. Alco Censor III can operate between 0° C and 40°C. The software to monitor diagnostic system requires proper battery power, proper instrument temperature, successful instrument pretest blank and the delivery of a "deep lung" breath specimen before automatically taking a sample. The disposable one-way mouthpiece is individually wrapped and can be automatically ejected from the instrument to avoid personal contact. A quick seating one way check valve is specifically designed to reduce the likelihood that a subject can suck back through the mouthpiece while submitting a sample. This mouthpiece is designed in a manner that it actuates the power up circuit on the Alco Sensor IV. Its design also facilitates the automatic ejection of the mouthpiece for hands free removal at the end of the test. (28)

Validity of breath analyzer test

Head space gas chromatography is the most validity to detect concentration of blood alcohol, but it is too expensive and difficult to keep. So breath analyzer is a substitution because it is less expensive and easily to carry for its small size. The last study found a high value of validity with correlation co-efficiency recorded at 0.971

(Blood: Breath ratio was 2378.93±440.26). There were few comparative studies of correlation co-efficient between breath test and blood test. Result had shown an equal value of correlation coefficient which was 0.987 and was very significant in statistic value at the level of 0.001. They studied of relationship of blood and Breath analyzer test (Alco-Sensor IV) in 120 patients who were traffic victims in the division of trauma, department of surgery, Siriraj hospital. (5) Another study had compared two breath analyzer test and gas chromatograph in 29 healthy volunteers after drinking alcohol beverage. The correlation coefficient (r) between two breath analyzers was 0.975 (n=143). The correlation coefficient (r) between Lion-Alcolmeter and GC was 0.977 (n=217), Alco-Sensor IV and GC was 0.971 (n=143). (20) In addition to the study about desktop (Alcohol Countermeasure series DATATEST JE-1100) and mobile breath analyzers (Alcohol Countermeasure system series PBA 3000) which had gas chromatograph was the goal standard in 140 study subjects included 90 volunteers and 50 polices who drank various alcohol beverage. The results of the study indicated that the desktop Breath Analyzer had a sensitivity of 96.46%, specificity of 74.04%, accuracy of 92.17% and the correlation was 0.925. The mobile Breath Analyzer had sensitivity of 44.25%, specificity of 92.59%, accuracy of 52.57% and the correlation was 0.625. (29)

In conclusion, the breath analyzer has high correlation coefficient value that can be used confidently to detect blood alcohol concentration. The effective of test was very close to blood test.

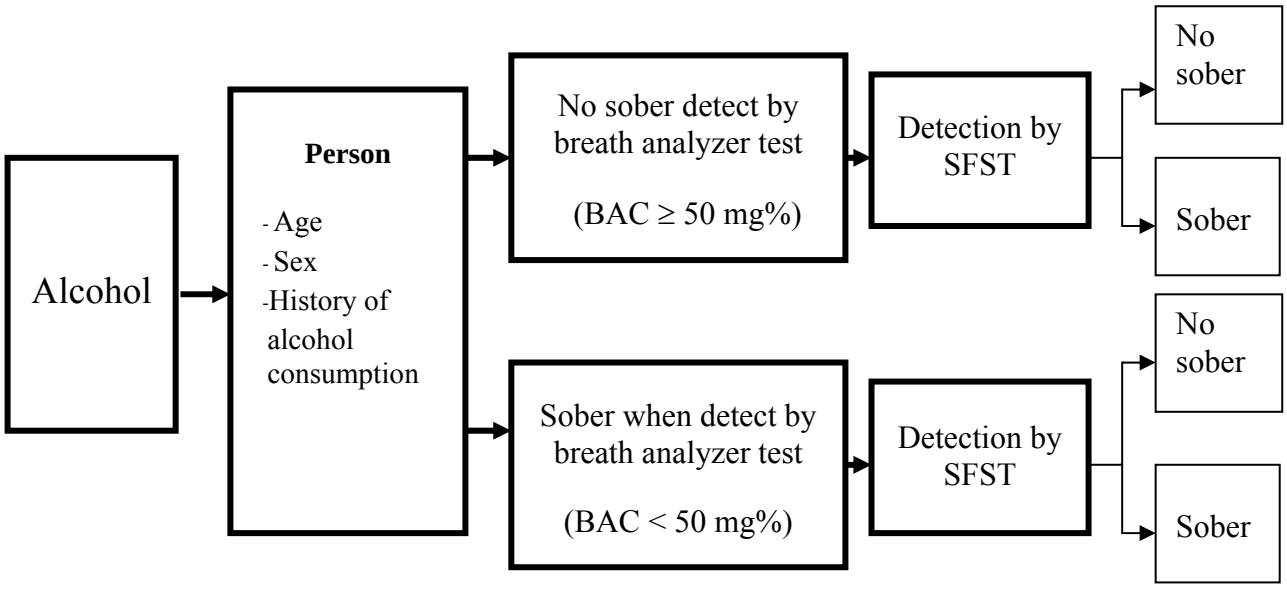

Figure 8 Conceptual Framework

CHAPTER III
MATERIALS AND METHODS

This chapter presents the research methodology, which consists of research design, population and sample, sampling method, sample size estimation, research instrument, reliability and research method. The purpose of this study focuses on the validity of the standard field sobriety tests.

1. RESEARCH DESIGN

This study was a cross-over design to study cross-sectional research on validation of the standard field sobriety tests for determining alcohol intoxication.

2. POPULATION AND SAMPLE

The study population in this study was 103 volunteers who live in Muang district, Buriram province. They were aged between 20 to 40 years.

3. SAMPLING METHOD

Inclusion criteria: participants were male and female from Buriram province, who accepted the informed consent, age between 20 to 40 years old, healthy; no history of underlying disease (renal, heart, liver, gastrointestinal, pulmonary disease or diabetes, and hypertension), no history psychotic disorder including substance abuse, or taking any prescribed psychoactive medication, no problem about vision or operated eyes (except short or long vision), and no problem about balance or operated knees area.

Exclusion criteria: the subject could not participate until the end of this study and who did not complete their breathe alcohol concentration testing always any period of the study.

4. SAMPLE SIZE

Sample size estimation are calulated by this formula (Zhou, X., Obuchowski, N.A., and McClish, D.K., 2002) (30)

$$n = \frac{Z^{2}_{1-\alpha/2}\nu(\hat{\vartheta})}{L^{2}}$$

$Z_{1-\alpha/2}$ = 1.96

$\nu(\hat{\vartheta})$ = the variance function of $\hat{\vartheta}$ (accuracy of SFSTs) = 0.94 (Sluster, J. and Burns, M., 1998)

L = the desired width of one half of CI = 0.05

n ≈ 87

n = 103

5. MATERIALS

The instruments of this study are composed of three parts as follow:

1. **Questionnaire**

It was recorded data of alcohol consumption: age start drinking, type of alcohol beverage, frequency and amount of drinking and health status: vision or operated eyes, balance or operated knees area

2. **Breath analyzer test**

The measurement of alcohol concentration in blood was performed by blasting into the breath analyzer. The Breath analyzer using in this study was the AlcoSensor IV which is a hand-held breath alcohol tester and automatically samples deep lung breath. The results are displayed in three-digit readout in mg% unit. The volunteers must rinse their mouths after drinking alcohol beverage to get rid off the remains of alcohol. Before using in this study, it has calibrated from agency that produced it.

3. **Standards Field Sobriety Tests** (SFSTs)

The SFSTs are the procedure to detect sober people who drink alcohol beverage. It used to perform coordination between mention and physical ability. The standardized battery includes three tests

3.1 **Horizontal Gaze Nystagmus** (HGN)

The HGN examination, the volunteer have to gaze the stimulus which moving horizontally. It is involuntary jerking of eyes. The examination for three signs in each eye yields a possible total score of six. The three signs are:

3.1.1 Lack of smooth pursuit: The eye of the volunteer can not smoothly pursue the moving stimulus but instead move in a jerky manner.

3.1.2 Nystagmus at maximum deviation: A distinct jerking occurs when the eye are deviated as far as possible in the horizontal plane.

3.1.3 Onset of the jerking movement prior to 45 degrees: Nystagmus occurs and persists at an angle of gaze less than 45 degree.

3.2 **Walk-and-Turn Test** (WAT)

A suspect is given detailed, standardized instructions for walking nine steps along a line as well as turning around and returning. A WAT score reflects an individual's ability attention and remember very specific instructions as well as balance and walk. The assistants record errors with the following checklist.

3.2.1 Loses balance during instructions

3.2.2 Starts before instructions finished

3.2.3 Stops while walking

3.2.4 Doesn't touch heel-to-toe

3.2.5 Steps off line

3.2.6 Uses arms for balance lose balance

3.2.7 Loses balance while turning

3.2.8 Incorrect number of step

3.2.9 Can't perform test

The WAT criterion for decision is two or more errors from a maximum score of eight.

3.3 **One-Leg Stand** (OLS)

This balance test requires each person stand with his/her arms at his side and lifts one leg approximately six inches off the ground. He/she looked at the raised foot and maintains the stance while counting from one thousand-one to one thousand-thirty. This test is in 30 seconds and scored as shown below.

3.3.1 Sways while balancing

3.3.2 Uses arms for balance

3.3.3 Hopping

3.3.4 Puts foot down

3.3.5 Can't perform test

The criterion for decision is two errors; it can be assumed that the decisions to intoxication were based on other signs of impairment. (21)

6. VALIDITY AND RELIABILITY

1. Content validity: one expert appropriate of language. It was then improved to be trained the researcher and two public health personnel.

2. Reliability testing: The inter-rater reliability was conducted by a researcher and two assistants. The value of reliability of pilot study using 10 volunteers was separated 2 phase folow as;

The pilot project was performed within two days. The first day is training the assistants of this work to gain understand the procedure and how to give a score correctly using the guideline from National Highway Traffic Safety Administration, USA. The assistants try to understand the guideline then study about movement of eye and balancing act from VDO. The balancing act is included walking step by step along a line and standing with one leg. The assistants try to test such procedure with the normal people to make sure they can measure correctly. The researcher demonstrated an example to assistants. The volunteer who have 150 mg% alcohol in their blood were brought to be examples. The researcher did measurement together with explanation abnormality of such volunteer and how to give a score. The assistants will do test by themselves began from Horizontal Gaze Nystagmus, Walk and Turn and One leg stand. The assistants do the test repeatedly until they were sure. The ne xt day, the assistants will do the test with the two volunteers who have 124 mg% and 32 mg% alcohol in their blood to confirm that they are really sure.

The second phase, the ten volunteers including eight male and two female were prohibited to have meal within four hours and drink within twenty four hours before testing. The researcher measured the alcohol level in their blood to make sure that all of them are not contaminated. The volunteers have to drink alcohol beverage one, two and finally four cans within one hour. Thirty minutes later, begin to measure alcohol

level using breath analyzer then do Horizontal Gaze Nystagmus, Walk and Turn and One leg stand testing, respectively. The assistants marked and recorded.

7. PROCEDURES

This study was separated into 2 phases:

Phase 1 Pilot study; Training for three research assistants by using the guideline from National Highway Traffic Safety Administration, USA. The assistants did the pre-test with ten volunteer, they have to do repeatedly until they are sure in procedure. (Inter rater will be calculated to evaluation of assistants testing)

Phase 2 Study phase; Announcement for invitation the volunteer, screening and selecting the healthy volunteers, explaining the objective of this study, demonstrate breath test. Administration divided the subjects by breath analyzer test and SFST. The subjects and assistants are blinded for BAC.

The Subjects were required to stop drinking any alcohol and having any meal for twenty four and four hour prior to testing, respectively. The first breath test will be checked for BAC = 0 mg% before begin the study. They have got the first drink after 10-15 minutes of arrival, and they have to complete drinking within one hour. They were randomly separated into three groups; the sober group (drink water), and drunk group including drinking two, and four cans of beer, respectively. Thirty minutes later, the participants were taken to breath test and performance of the SFST battery.

The subjects who have no BAC are requested to perform SFSTs to baseline assessment. They are request to detect alcohol level by breath analyzer and classify to sober and no sober at 50 mg% BAC then perform SFST all 3 tests (Horizontal Gaze Nystagmus, Walk and Turn, One leg stand). The criteria of decision sober are indicated each tests. In this study, we set the clock and record time when begin each tests until the end of performance.

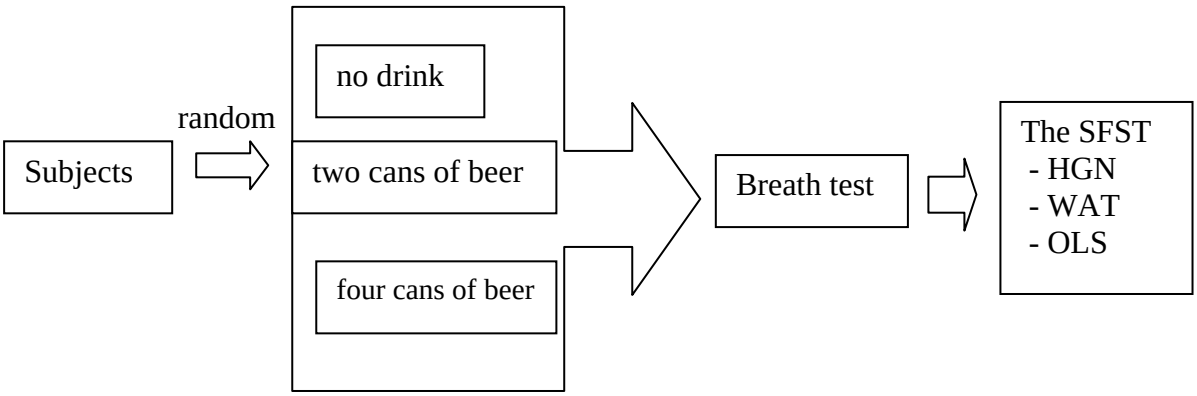

Figure 9 A plans of procedures in this study

7. STATISTICAL ANALYSES

The Statistical Package of Social Science for Personal Computer Window version 11.5 is used to analyze the data.

1. The frequency, percentage, mean and standard deviation are used to descriptive statistics which describe the demographic data such as sex, age, marital status, education level, occupation, family income, vehicle, duration of alcohol intake, age of the first drink, frequency, quantity of alcohol intake and type of alcohol beverage.

2. Sensitivity, specificity and predicted value were obtained to confirm the validity of the score when compare to breath analyzer test which blood alcohol concentration cut-off point BAC. Sensitivity represents the rate of participants who were sober identifies by breath test. Specificity refers to rate of participants who were not sober identified by the same test. The positive predicted value indicates the rate of participants who were sober as cut off point of BAC identified by breath test, and negative value refers to the rate of participants who were not sober as legal limited below cut off point of BAC. The area under the curve (AUC) of the receiver-operating characteristic (ROC) was calculated to asses the overall validity of the score and it can present 95% confidence interval for AUC. The ROC is used to confirm the validity and decision – making the efficiency score. The ROC graph can be drawn by linking the points on the coordinates consisting of the sensitivity on Y-axis and 1-

specificity on the X-axis using all the values in the score. A high AUC value means a high validity. If the test presents a high AUC, it can identify and classify the participants who are sober or not sober as legal limited.

3. Kappa coefficients are measures of correlation between two tests. The statistics is a way to quantify the level of agreement. It is quantified actual levels of agreement which can verify exceeds chance levels such as;

Exceeding 0.75	excellent agreement
0.40-0.75	fair to good agreement
Less than 0.4	poor agreements. (31)

CHAPTER IV
RESULTS

This study investigated the efficiency of the standard field sobriety test for determining alcohol intoxication from volunteers who living in Buriram province. The results are presented in term of sociodemographical, historical alcohol consumption, blood alcohol concentration of breath analyzer test and the reliability, validity and agreement of the standard field sobriety test.

Part 1 Data of sociodemographical

The participants in this study are consisted of 103 healthy persons who living in Buriram province. The majority of them were male, mean age was 26.5 years old, single, achieved only primary school, labour employee, income less than 3,000 bath per month. Approximately 3 in 4 of their vehicle were motorcycle.

Table 5 Sociodemographic characteristics of participants

Characteristics	N	%
Sex		
Male	79	76.7
Female	24	23.3
Age (Years)		
20 - 24	51	49.5
25 - 29	20	19.5
30- 34	16	15.5
35 - 40	16	15.5
Mean (SD)	26.5 (6.4)	
Marital status		
Single	66	64.1
Couple	34	33.0
Separated	3	2.9

Table 5 Sociodemographic characteristics of participants (continued)

Characteristics	N	%
Education level		
Illiterate	4	3.9
Primary school	43	41.7
High school	32	31.1
Vocational school	8	7.8
University	16	15.5
Occupation		
Agriculturist	32	31.1
Labor employee	46	44.6
Household job	3	2.9
Others	22	21.4
Family income per month (Bath)		
< 3,000	69	67.0
3,001-5,000	25	24.3
5,001-7,000	9	8.7
Vehicle		
None	27	26.2
Motorcycle	69	67.0
Car	7	6.8

Part 2 Data of historical of alcohol consumption

The first drinking of the participants began from aged 12, while mean of age of drinking was 17.9 years old. More than half of them had intake alcohol beverage were less than 8 years. Interestingly, approximately half of them drank 1-2 days per week (42.9 %) and intake at least 56.4 gm in the part week (48.6%).

Table 6 Historical of alcohol consumption of the participants

Characteristics	N	%
The first drunk (years)		
12-18	71	68.9
19-25	27	26.2
≥ 26	5	4.9
Mean (SD)	17.9(3.8)	

Table 6 Historical of alcohol consumption of the participants(continued)

Characteristics	N	%
Duration of alcohol intake (years)		
< 8	59	57.3
9-16	33	32.0
≥ 17	11	10.7
Mean (SD)	8.7(5.7)	
Frequency of drinking per week (days)		
<1	27	26.2
1-2	45	43.7
3-4	31	30.1
Quantity of alcohol intake per week (gm)		
< 55.0	49	47.6
55.0-109	34	33.0
≥ 110	20	19.4
Mean (SD)	55.9 (52.6)	

Part 3 Blood alcohol concentration of breath analyzer test

The blood alcohol concentration of the participants falls within the range 0 - 161 mg%. The majority of them had BAC groups 0-9 mg% (12.6%), both of groups 20-29 mg% and 60-69 mg% were 11.7% and 70-79 mg% (9.7%). The average of BAC was 58.3 mg% (SD= 42.6 mg %).

Table 7 Blood alcohol concentration of breath analyzer test

BAC (mg %)	N	%
0-9	13	12.6
10-19	8	7.8
20-29	12	11.7
30-39	8	7.8
40 -49	7	6.8
50-59	5	4.9
60-69	12	11.7
70-79	10	9.7
80-89	4	3.9
90-99	6	5.8
100-109	5	4.9
110-119	2	1.9

Table 7 Blood alcohol concentration of breath analyzer test (continued)

BAC (mg%)	N	%
120-129	3	2.9
130-139	2	1.9
140-149	2	1.9
≥150	4	3.9
Total	103	100.0
Mean (SD)	58.3 (42.6)	
Range	0-161	

Part 4 The reliability, validity and agreement of the tests

The reliability of the standard field sobriety test was assessed from three observers and ten volunteers. Mean of age are 32.5 years old and the volunteers who are 21-40 years old posses alcohol level in their blood 58.8 mg %. SD=40.1, range 0-129 mg %). The inter-rater reliability found intraclass correlation coefficients of each test; horizontal gaze nystagmus, walk and turn and one leg stand were 0.968 (95%CI=0.907-0.991), 0.977 (95%CI=0.931-0.994), and 0.977 (95%CI=0.931-0.994), respectively.

The average duration of administration was 3.56 minutes. (horizontal gaze Nystagmus = 1.08 minutes (SD=0.27), walk and turn= 1.21 minutes (SD=0.46), and one leg stand = 1.27 minutes)

Table 8 Duration of administration of the standard field sobriety test

Test	Mean (minutes)	SD
Nystagmus	1.08	0.27
walk and turn	1.21	0.46
one leg stand	1.27	0.47
Total	3.56	0.71

The validity screening tests and agreement for a newly tests are summarized each test when compare to breath analyzer test which blood alcohol concentrate cut-off point separate 16 intervals (range = 10) were performed on 103 participants. The data collected as follow:

1. Horizontal Gaze Nystagmus (HGN)

The validity of horizontal gaze nystagmus test has been shown by scoring as follow;

Score = 1, the receiver operating characteristics (ROC) curve to assess this test and the area under curve (AUC) was 0.980 (95%CI = 0.960-1.001), was statistical significance at p-value < 0.001. The validity of horizontal gaze nystagmus test; the appropriately cut point of BAC was 30 mg%, it was given the value of sensitivity, specificity, positive and negative predictive value were 97.1%, 84.8%, 93.2%, and 93.3%, respectively. It had the highest value of the accuracy was 93.2 and the excellent agreement was 0.840

Score = 2; the sensitivity, specificity, positive and negative predictive value, and accuracy appropriately was cut off 70 mg%BAC; were 84.2%, 80.0%, 71.1%, 89.7% and 81.6%, respectively. The kappa value was 0.623, acceptable level that was statistical significance at p-value < 0.001. It was confirm with the receiver operating characteristics (ROC) curve, area under curve (AUC) was 0.895 (95%CI = 0.835-0.956), was statistical significance at p-value < 0.001.

Score = 3; the cut point of BAC found appropriately was 80 mg%BAC was given the best validity; sensitivity, specificity, positive and negative predictive value, and accuracy were 64.3%, 92.0%, 75.0%, 87.39%, and 84.5% respectively. The value of kappa was 0.589 that the high value which fair to good agreement. The area under curve of the receiver operating characteristics (ROC) was 0.906 (95%CI = 0.845-0.966), was statistical significance at p-value < .001.

Score = 4; 0.813 (95%CI = 0.714-0.912) was the area under curve (AUC) of the receiver operating characteristics (ROC) which was statistical significance at p-value < .001. The validity of it at the cut point of BAC found appropriately was 80 mg%BAC; sensitivity, specificity, positive and negative predictive value were 32.1%, 94.7%, 69.2%, and 87.4%, respectively. The accuracy value was 77.7% that poor agreement of kappa statistical (0.322)

Score = 5; The accuracy value was 89.32%, sensitivity=15.4%, specificity=100%, positive predictive value=100% and negative predictive value=89.1% which cut point of BAC appropriately was 110 mg%BAC the receiver operating characteristics (ROC) curve to assess this test and the area under curve

(AUC) was 0.926 (95%CI = 0.862-0.989), was statistical significance at p-value =0.040. The kappa statistical was 0.241 that poor agreement.

Score = 6; the validity was sensitivity=7.7%, specificity=100%, positive predictive value=100%, negative predictive value=88.2%, and accuracy=88.2%, appropriately was cut off 110 mg%BAC. The kappa value was 0.127, acceptable level that was statistical significance at p-value < 0.001. It was confirm with the receiver operating characteristics (ROC) curve, area under curve (AUC) was 0.887 (95%CI = 0.826-0.949), was statistical significance at p-value < 0.001.

The study of the reliability of standard field sobriety test by HGN using score 0-6 to determine alcoholic intoxication found that score=1 has the highest validity when sensitivity, specificity, positive and negative predictive value were 97.1%, 84.8% and 93.2%, 93.3%, respectively, and value of accuracy was 93.2% and the excellent agreement was 0.840 provided the cut point of BAC was 30mg%.

Table 9 Validity of HGN

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
1*	30	97.1	84.8	93.2	93.3	93.2	0.840
2	70	84.2	80.0	71.1	89.7	81.6	0.618
3	70	57.9	96.9	91.7	79.9	82.5	0.594
4	70	28.9	96.9	84.6	70.0	71.8	0.300
5	110	15.4	100	100	89.1	89.3	0241
6	110	7.7	100	100	88.2	88.3	0.127

2. Walk and Turn (WAT)

The validity screening tests of walk and turn test was shown value by score was;

Score = 1, the receiver operating characteristics (ROC) curve to assess this test and the area under curve (AUC) was 0.734% (95%CI = 0.635% - 0.832%), was statistical significance at p-value <.001. It appropriately BAC cut off was 50 mg% which had the sensitivity, specificity, positive predictive value, negative predictive

value and accuracy were 76.4%, 64.6%, 71.2%, 70.5%, and 70.9%, respectively. The high value of the agreement was 0.412 that fair to good level.

Score = 2, the sensitivity, specificity, positive and negative predictive value, and accuracy appropriately was cut off 110 mg%BAC; were 61.5%, 68.9%, 22.2%, 92.5% and 68.0%, respectively. The kappa value was 0.173, acceptable level that was statistical significance at p-value < 0.001. It was confirm with the receiver operating characteristics (ROC) curve, area under curve (AUC) was 0.743% (95%CI = 0.648% - 0.839%), was statistical significance at p-value < 0.001.

Score = 3, 0.704 (95%CI = 0.601% - 0.807%) was the area under curve (AUC) of the receiver operating characteristics (ROC) which was statistical significance at p-value < .010. The validity of it at the cut point of BAC found appropriately was 70 mg%BAC; sensitivity, specificity, positive and negative predictive value were 28.9%, 92.3%, 68.8%, and 69.0%, respectively. The accuracy value was 68.9% that poor agreement of kappa statistical (0.242)

Score = 4, ; the cut point of BAC found appropriately was 70 mg%BAC was given the best validity; sensitivity, specificity, positive and negative predictive value, and accuracy were 15.8%, 98.5%, 85.7%, 66.7%, and 68.0%, respectively. The value of kappa was 0.172 that the poor agreement. The area under curve of the receiver operating characteristics (ROC) was 0.719% (95%CI = 0.580% - 0.858%), was statistical significance at p-value =0.054.

Score = 5, the receiver operating characteristics (ROC) curve to assess this test and the area under curve (AUC) was 0.621% (95%CI = 0.454% - 0.789%), was statistical significance at p-value =0.413. It appropriately BAC cut off was 70 mg% which had the sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 75.0, 64.6, 7.9, 98.5 and 65.0, respectively. The high value of the agreement was 0.078 that poor level.

Score = 6, the validity was sensitivity=2.6%, specificity=98.5%, positive predictive value=50.5%, negative predictive value=63.4%, and accuracy=63.1%, appropriately was cut off 70 mg%BAC. The kappa value was 0.014, acceptable level that was statistical significance at p-value < 0.001. It was confirm with the receiver operating characteristics (ROC) curve, area under curve (AUC) was 0.520% (95%CI = 0.282% - 0.758%), was statistical significance at p-value =0.924.

The study of the reliability of the standard field sobriety test by WAT using score 0-6 to determine the alcoholic intoxication found that score=1 has the highest validity when sensitivity, specificity, positive and negative predictive value were 76.4%, 64.6% and 71.2% and 70.5%, respectively, and value of accuracy was 70.9% and the excellent agreement was 0.412. These given value was considered relative fair to good when the cut point of BAC was 50mg%. It has the validity to determine alcoholic intoxication correctly 76.4%.

Table 10 Validity of WAT

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
1*	50	76.4	64.6	71.2	70.5	70.9	0.412
2	60	56.0	84.9	77.8	67.2	80.6	0.412
3	60	28.0	96.2	87.5	58.6	53.4	0.247
4	70	15.8	98.5	85.7	66.7	68.0	0.172
5	70	7.9	98.5	75.0	64.6	65.0	0.078
6	70	2.6	98.5	50.0	63.4	63.1	0.014

3. One leg stand (OLS)

The validity screening test of one leg stand test was shown each score follow as;

Score= 1, the receiver operating characteristics (ROC) curve to assess this test and the area under curve (AUC) was 0.695% (95%CI = 0.591% - 0.799%), was statistical significance at p-value =0.002. It appropriately BAC cut off was 60 mg% which had the sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 46.0%, 83.0%, 71.9%, 62.0% and 65.0%, respectively. The high value of the agreement was 0.293 that poor level.

Score= 2, the sensitivity, specificity, positive and negative predictive value, and accuracy appropriately was cut off 50 mg%BAC; were 34.5%, 91.7%, 82.6%, 55.0%, and 62.2%, respectively. The kappa value was 0.251, acceptable level that was statistical significance at p-value < 0.001. It was confirm with the receiver operating

characteristics (ROC) curve, area under curve (AUC) was 0.664% (95%CI = 0.561% - 0.767%), was statistical significance at p-value =0.017.

Score= 3, the receiver operating characteristics (ROC) curve to assess this test and the area under curve (AUC) was 0.696% (95%CI = 0.586% - 0.807%), was statistical significance at p-value =0.053. It appropriately BAC cut off was 50 mg% which had the sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 16.4%, 100%, 100%, 51.1% and 55.3%, respectively. The high value of the agreement was 0.154 that poor level.

Score= 4, 0.730% (95%CI = 0.609% - 0.852%), statistical significance at p-value =0.059 was the area under curve (AUC) of the receiver operating characteristics (ROC) which was statistical significance at p-value < .001. The validity of it at the cut point of BAC found appropriately was 70 mg%BAC; sensitivity, specificity, positive and negative predictive value were 13.2%, 98.5%, 83.3%, and 66.0%, respectively. The accuracy value was 67.0% that poor agreement of kappa statistical (0.141)

Score= 5, the cut point of BAC found appropriately was 120 mg%BAC was given the best validity; sensitivity, specificity, positive and negative predictive value, and accuracy were 9.1%, 97.8%, 33.3%, 90.0% and 88.38%, respectively. The value of kappa was 0.102 that poor level. The area under curve of the receiver operating characteristics (ROC) was 0.722% (95%CI = 0.518% - 0.926%), was statistical significance at p-value =0.192.

Score= 6, the validity was; sensitivity = 9.1%, specificity = 98.9%, positive predictive value = 50.0%, negative predictive value=90.1%, and accuracy = 89.3%, appropriately was cut off 120 mg%BAC. The kappa value was 0.125, acceptable level that was statistical significance at p-value < 0.001. It was confirm with the receiver operating characteristics (ROC) curve, area under curve (AUC) was 0.703 (95%CI = 0.406 – 1.00), was statistical significance at p-value =0.327.

The study of the reliability of the standard field sobriety test by OLS using score 0-6 to determine the alcoholic intoxication found that score=1 has the highest validity when sensitivity, specificity, positive and negative predictive value were 45.5%, 85.4% and 78.1% and 57.7% respectively, and value of accuracy was 64.1% and the excellent agreement was 0.300 and cut point of BAC was 50 mg%

Table 11 Validity of OLS

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
1*	50	45.5	85.4	78.1	57.7	64.1	0.300
2	50	34.5	91.7	82.6	55.0	62.2	0.251
3	50	16.4	100	100	51.1	55.3	0.154
4	70	13.2	98.5	83.3	66.0	67.0	0.141
5	120	9.1	97.8	33.3	90.0	88.3	0.102
6	120	9.1	98.9	50.0	90.1	89.3	0.125

When analyzing the data by Ven diagram (17) using the cut point of BAC 50 mg% and applying the most appropriate validity score of each testing methods, i.e. HGN score =2, WAT and OLS score = 1), it was found that HGN, WAT and OLS could determine following number of intoxicated volunteers 44, 59 and 30 respectively. But when using combined methods between HGN and WAT, the highest number of intoxicated volunteers, 35 people, were identified. If combining the 3 mehtods, 21 volunteers were identified to intoxicated.

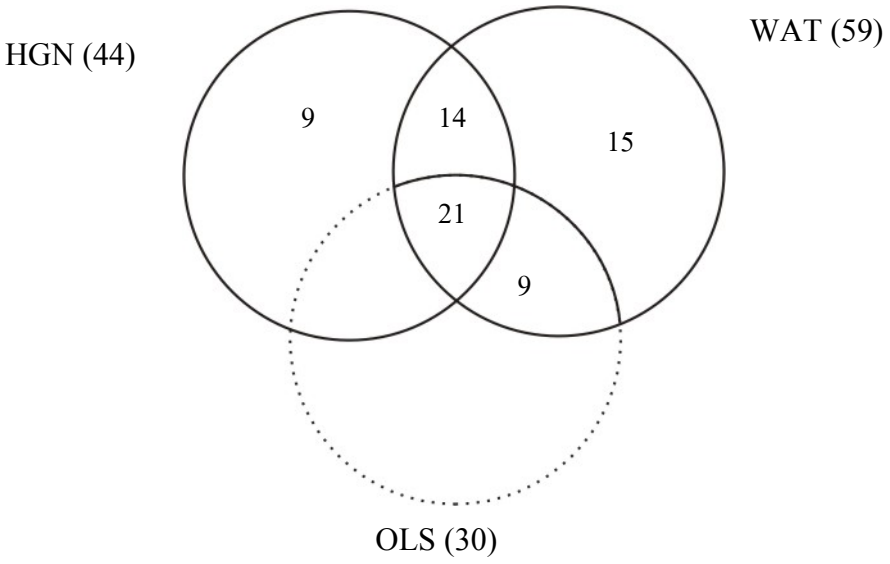

Figure 10 Venn diagram of SFST

When analyzing the validity to select each method by considering various conditions i.e. applying 1 method, applying 2 (parallel multiple tests-it had a high sensitivity, low specificity, sample in the border line of BAC was selected to positive group, for another test was positive, the result of all will be positive too.) (33) and 3 combining methods, it was found that the highest value of accuracy (78.7%) derived from HGN testing, and kappa value was 0.576 (p-value<.001) was considered fair to good.

Table 12 The reliability of the standard field sobriety test

Method	test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
Single	HGN	70.9	87.5	86.7	72.4	78.7	0.576
	WAT	76.4	64.6	71.2	70.5	70.9	0.412
	OLS	45.5	85.4	78.1	57.7	64.1	0.300
Combine	HGN&WAT	87.3	56.31	69.6	79.4	71.43	0.443
	HGN&OLS	78.2	75.0	78.2	75.0	76.7	0.532
	WAT&OLS	78.2	62.5	70.5	71.4	70.9	0.410
	Overall	87.3	78.8	68.6	78.8	71.85	0.423

CHAPTER V
DISCUSSION

As a result of validity of standard field sobriety test in drunkard, it can be divided into two sections; study design and methodology, and study result with the following details.

Discussion on study design and methodology

This study was cross-sectional analytic study, which study both of healthy men and women whom 20-40 years old. Everyone had received a basic vision field check such as the operation, blindness or ability of vision that would be consequence with horizontal gaze nystagmus Test and balance test to maintain body, for example, leg operation, unbalanced legs or the disease about bone and joint. This factor had an effect with walk and turn test and one leg stand test. For the genuine result of drunk, study in adjoining age group should be reducing a problem of ensuring drunkard that naturally occurs in person who always drinking or drunk for a long time. The ensuring person would not or a little bit express the drunken symptom that would pull the truth of result down (11)

This project had studied by three observers; researcher and two assistant researchers. They were public health officers who had trained for the correct methods of test, observe the symptom, including the way to give scores to separate drunk and usual. They were processing on pilot project which divided into two parts. The first one was theory that researchers had instructed and practiced by guideline from National Highway Traffic Safety Administration, USA (19) and also learned from video source about the way that eyes change their position in line level and balance way to maintain body. After that maad an experiment between drunk and usual, the drunkard who had more than 50% compare with the one who had less than 50% of alcohol level, deadline to divide drunk and usual in law. Continue to second part, practicing, three researchers were given practice to testers who had different level of

beer by all of three methods each. Then used the result to calculate for inter-rater reliability. In each method had found that the age of ten testers were average in 32.5 years old (SD= 7.4), 20-40 years old group had an average alcohol level 58.8 mg%(SD=40.1, range 0-129 mg%), inter-rater reliability of horizontal gaze nystagmus = 0.968 (95%CI=0.907-0.991), Walk and Turn = 0.977 (95%CI=0.931-0.994) and One leg stand = 0.977 (95%CI=0.931-0.994). It had a really high level which made confident that testers had no different to test on this equipment as same as the study of the early equipment in 1981 with inter-rater reliability in each method; horizontal gaze nystagmus= 0.66, walk and turn=0.83, and one leg stand=0.86 (32)

Testers and observers were blinded, rejecting to aware of alcohol level by breath. Testers had been randomed to drinking alcohol in different level that also allow equipment test in many levels. However, testers were hard and unnaturally that was the problems of walk and turn test and one leg stand test. Observer's bias was not occur if they known the level of alcohol in blood of testers so they had more intend and gave more or less scores to be in agreement with alcohol level that made the result inexactly. (33)

Discussion on study result

The results of BAC which test by breath was 0-161 mg%, average 58.3 mg% (SD=42.6) that less than the studied before. In 1997 (N=256) had a level of alcohol in blood amount 0-151 mg%, average 110mg% (16) and in 1998 (N=297) had an average 122 mg%. It shown that when the average of BAC was high, sensitivity was high either. That's mean high BAC was more sentitive to separate drunkard than low level as same as this study result (22).

Table 12 Mean of BAC, 1977-2006

Year	N	Mean (SD)	Range	Sensitivity (%)	Cut-off BAC (mg%)
1977	238		0-150	54	100
1981	297		0-180	81	100
1997	256	110	0-151	95	80
1998	297	122		90	80
2006	103	58.3 (42.6)	0-161		50

The validity of SFST in three methods (HGN, WAT, and OLS) was highest respective when judged at one point such as HGN (cross point of alcohol level in blood at 30mg %), sensitivity, specificity, and accuracy were 97.1%, 84.8%, and 93.2% respectively which the excellent agreement (0.840). WAT (cut point of BAC at 50mg%), sensitivity = 76.4%, specificity = 64.6, accuracy = 70.9%, and value of agreement is fair to good point (0.412). OLS had sensitivity, specificity, and accuracy at 45.5%, 85.4%, and 64.1% respectively. Value of agreement was poor (0.300). The approximately validity of HGN when used cut off BAC was interval 10mg% to 40 mg% which score as 1 but more 50 mg% that score as 2 was better. In contast, score as 1 of the two balance test were better all cut off BAC. That's mean to observe eyes vision is faster than observe balance. When the bBAC was low (30 mg%), it was good to observe the unusual from eyes vision but to observe the balance to maintain body was only do in higher level (50 mg%). At the same time when alcohol level in blood was equal (50 mg%), to observe eyes vision was better (sensitivity =70.9%, specificity = 87.5%, and accuracy = 78.7%). The value of agreement was fair to good (0.576) by use two points as a judgment. It was linked with the study result in the past that eyes vision test had more efficiency than two tests of the balance (11, 20, and 22). It mean when the BAC was increasing, eyes vision should bel shown more unusual symptom (symptom = scores). It was natural reaction of abnormal eyes vision when there weree alcohols in blood. Eyes muscle central control in center nerve system should been irregular, eyes had more difficult to roll and jerk when gaze at object that move to the most remote from eyes canthus (35, 36). From last studied, was found that level of alcohol at 50 mg% was effect eyes vision in case of to guess the deep of object and to accommodation after glare (18), linking to this study which found that low BAC (30 mg%) can indicate the abnormal of eyes vision and it was increase when level was higher (50mg%). Two methods of balance test maintain body were the connecting work between nerve systems and body movement that had to be related with the strong muscle and good sense of touch. From this study, the testers were between 20-40 years old and healthy. Most of them were agriculturist and wage earner. Besides, the average of alcohol level in blood is 58.3 mg%, stays in border line of drunk or usual judgment, cause of low respective of two methods of balance From the past research was found that level of alcohol in blood at 60 mg% changed

nerve system situation effected to body movement control, at 90 mg% affected to connection of nerve and muscle, at 100 mg% occurred apraxia symptom, difficult movement, unknotting muscle, and deteriorate of joining of nerve thought and muscle (7, 18). Shortly, alcohol level in blood at 50 mg% will be effect to nerve and movement system cause of unusual expressing. Furthermore, the average of BAC was less than the level that two methods of balance way to maintain body could be check; the respective was less than eyes vision checks also. According to Thailand's law, the level of BAC at 50 mg% was drunk, it occurred to prevent accident made by the accident study from risk of blood alcohol level. In conclude, at the BAC 100 mg%, 80 mg%, and 50 mg% had a chance to cause accident 16 %, 10 % and 6 % respectively. Thus, the illegal compel of alcohol level in blood was 50 mg% to decrease the number of accident from Thai drunk (37). Therefore, SFST equipment to separate drunk and usual had to use HGN that would be successfully 78.7 %.

Table 14 Validity of SFST each test, 1983 to 2006

SFST	Year	N	Sensitivity(%)	Specificity(%)	Accuracy(%)	BAC (mg%)
HGN	1998	297	87.0	93.0	88.0	80
	2006	103	70.9	87.5	78.7	50
WAT	1998	297	82.0	69.0	79.0	80
	2006	103	76.4	64.6	70.9	50
OLS	1998	297	86.0	73.0	83.0	80
	2006	103	45.5	85.4	64.1	50

Limitations of the study

This research studies a small group of people in Buriram province because of limit time and budget. There were 103 testers who live in same area with observers for the comfortable transportation.

Actually Thai people had many choices of alcohol drink but in this research "Beer Thai" was one selected.

Strength of the study

This was the first time of equipment study, Standard Field Sobriety Test, in Thailand which different from European or white people in body and metabolism including alcohol drinking culture. Moreover, this research had already eliminated the causes that were problem the result such as limited in adjoining age group and healthy that different from research in the past. All of three observers had trained and they could observe with the same quality result. As a result in pilot project section had a really high inter-rater reliability. While the test observers blinded for the BAC before so the result was exactly validity.

CHAPTER VI
CONCLUSION AND RECOMMENDATION

1. Study summary

This research was a population-based cross-sectional analytical study. The purpose was to study the validity of the standard field sobriety tests (SFST) compare with breath analyzer test to determine alcohol intoxication in Thai people. The data collected by researcher and the assistants between 2006, July 10-15. There were 103 healthy volunteers co-operated in this research. The calibrated breath analyzer test using in this study was the Alco Sensor IV. The study has separated into 2 phases. The first phase was pilot study. Three research assistants were trained and ten persons were put on initial trial study (the inter-rater reliability value of Horizontal Gaze Nystagmus, Walk and Turn and One leg stand were 0.968 (95%CI=0.907-0.991), 0.977 (95%CI=0.931-0.994) and 0.977 (95%CI=0.931-0.994). The second phase was study period; the volunteers were randomized to classify to three groups of varied blood alcohol concentration. Then, they underwent a breath test and performing the SFST battery which blinded blood alcohol concentration.

The data was analyzed by descriptive statistics using to explain socio-demographical and alcohol consumption. The validity of the tests was analyzed to confirm the results of decision of the tests and confirm correlation and agreement between two tests with kappa coefficient. The ROC curve is used to calculate the cut-off the score of the tests the validity and decision – making the efficiency score. The average duration of administration was 3.56 minutes. (horizontal gaze nystagmus = 1.08 minutes (SD=0.27), walk and turn= 1.21 minutes (SD=0.46), and one leg stand = 1.27 minutes)

The majority of volunteers were male which had blood alcohol concentration within a range 0 to 161 mg%. The average BAC was 58.3 mg% (SD= 42.6 mg %). The standard field sobriety tests was concluded orderly; horizontal gaze nystagmus, At score = 1, at the cut off 30 mg%BAC possesses sensitivity, specificity, and accuracy were 97.1%, 84.8%, and 93.2%, respectively which the excellent

agreement was 0.840. At score = 1 with cut off 50 mg%BAC Both of balance test: walk and turn, possesses sensitivity, specificity, and accuracy 76.4%, 64.6%, and 70.9%, respectively , and agreement value was 0.412**.** The one leg stand possesses sensitivity, specificity, and accuracy was 45.5%, 85.4%, and 64.1%, respectively which kappa statistic was 0.300. At the same cut off BAC of both balance test found that the best validation and agreement of horizontal gaze nystagmus were score = 2, accuracy = 78.7%, sensitivity = 70.9%, specificity = 87.5% and kappa =0.567.

In conclusion, the standard field sobriety tests could not apply to use as the detecting method as breath analyzer test to classify the drunk driver who was alcoholic intoxication or sober person because it show no good agreement. The horizontal gaze nystagmus test was suitable to use with the best predicted decision for sober or not sober based on the legal limit BAC when it was used as a single test. But it can use for the first screening of people who was under alcohol influences to reduce accident.

2. Recommendation on this study result

Standard field sobriety test was good applied to determine the conscientious of alcoholic drinkers so as to reduce the road accidents caused by drunk drivers. However, the Standard field sobriety test could be more effective if it was applied together with the breath analyzer test.

3. Recommendation for further study

1. The standard field sobriety tests should be done in the field and a various kind of population to assess the effective of this test.
2. The standard field sobriety tests should be studied in larger population for the most powerful result
3. This test should be used by the police to apply on the road side for a real study.
4. A variety of alcohol beverages should be used in this test.

REFERENCES

1. Devision HI. Number of death and death rates per 100,000 persons by leading causes of death, 1999 -2003. Nonthaburi: Bureau of Health Policy and Plan; 2005.
2. Srithamma S. Burden of disease for priority of health problem in Thailand 1999: The Thai working group on burden of disease and injury. Journal of health science 2004; 13(2):239-56.
3. Namwath C. Conclusion of trend and risk factors of injury from traffic accident in Thailand during 1987-2004: Bureau of health policy and plan, Ministry of public health, Thailand; 2005.
4. Pholeamek S, Sasithonrojanachai W. Relationship of blood and breath alcohol concentration in traffic victims. Bangkok: Mahidol University; 1994.
5. Tonmukayakul A, Sasithornrojanachai W. Alohol and injury. Siriraj hospital gazette 1996;48:1-11.
6. Sontikan C, Damnakkeaw K. National injury sueveillance report: Severe injury due to transport accidents in new years festival 2004. Thai journal of trauma 2004;23 (2):75-82.
7. Insel P, Turner R.E, Ross D. Spotlight on alcohol. Massachusetts: Jones and Bartett; 2002.
8. Thailand health profile 1999-2000. Ministry of public health, Nonthaburi; 2004.
9. Alcohol intoxication testing [Online]. Available from: File:http://www.alcohol_intoxication_testing.htm [20 Dec, 05].
10. Burns M. and Anderson E. W. A Colorado validation study of the standardized field sobriety test (SFST) battery: National highway traffic safety adminstration,USA.; 1995.
11. Burns MaM, H. Psychophysical tests for DWI arrest: National highway traffic safety adminstration USA; 1977.
12. Caetano R., Clark C.L., Tam T. Alcohol consumption among ethnic minorities: Journal of alcohol health and research world, 1998, vol. 22: 233-41.

13. Brody T. Nutritional Biochemistry. California: Academic Press; 1999.
14. Pati K. Alcohol consumption related to essential hypertension in Nan Province [Public Health]. Bankok: Mahidol University; 2004.
15. Anderson TE, Schweitz, R. M. and Snyder, M. B. Field evaluation of a behavioral test battery for DWI: National highway traffic safety adminstration USA; 1983.
16. Baraona E., et al. Gender difference in pharmacokinetics of alcohol: Journal of alcohol clinical and experimental research, 2001, vol. 25: 502-7.
17. Health Information Devision BoHPaP. Number of deaths and death rates per 100,000 population by leading causes of death,1997-2003. Nonthaburi; 2004.
18. วิสูตร ฟองศิริไพบูลย์, จันทรพิมพ์ เจียมพงศ์พันธุ์. การเมากับระดับแอลกอฮอล์ในเลือด. วารสารอุบัติเหตุ, 2543; ปีที่ 19 ฉบับที่ 3: 181-2.
19. Lederman P.H., Snowden G. DWI field sobriety testing fact and fiction. National highway safety transportation administration; [Online]. Available from: File: http://www.nj-dwi.com/sobriety-1htm [13 Oct, 05].
20.Chinnavejkitvanij V, Planuvej C, Issaravanij S. Detection of blood alcohol by breath analyzer and gas chromatograph after drinking alcohol beverage. Nakornprathom: Mahidol University; 1996.
21. Burns M et all. A Florida validation study of the standardized field sobriety test (SFST) battery: National highway traffic safety adminstration, USA; 1997.
22.Stuster J., Burn M. Validation of the SFST battery at BACs below 0.10 percent: National highway traffic Safety aminstration,USA; 1998.
23.Papafotiou K. An evaluation of the efficiency of sobriety testing to detect blood levels of cannabis and impaired driving ability ; 2001.
24 Jackson P.G, Tunbridge R.J and Rowe D.J. drug recognition and field impairment testing: Department of environment transport and the regions, Transport research laboratory, London, United Kingdom; 1999
25. Boorman M.C. Detection of drug impaired drivers standard field sobriety tests: Traffic alcohol section—Technical unit, Victoria police Melbourne, Victoria, Australia; 2000

26. Tzambazis K. and Stough C. The SFST and driving ability, are they related: Drug and Driving Research unit, Swinburne University of Technology, Victoria, Australia; 2000

27 Heishman S, Singleton E.G and Crouch D.J. Laboratory validation study of drug evaluation and classification program: ethanol, cocaine, and marijuana: Journal of analytical toxicology, 1996, vol. 20: 468-83.

28. AlcoPro. Alco-sensor IV [Online]. Available from: File: http://www.alcopro.com. [02 Dec, 06].

29. Charoenprasert S. Screening test for blood alcohol concentration by breath analyzer. (M.S Thesis). Bangkok: Faculty of Graduate studies, Mahidol University; 1997.

30. Zhou X, Obuchowski, N.A., and McClish, D.K. Statistical methods in diagnostic medicine. New York, USA: John Wiley & Sons, Inc.; 2002.

31. Gerstman B.B. Epidemiology kept simple. New Jersey, USA: John Wiley & Sons, Inc.; 2003: 81

32. Tharp V, Burns, M. and Moskowitz, H. Development and field test of psychophysical tests for DWI arrest: National highway traffic safety administration, USA; 1981.

33. อมรรัตน์ โพธิพรรค. หลักระบาดวิทยา. คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล, กรุงเทพมหานคร; 2546: 11-8-9.

34. DUI information field sobriety tests summary [Online]. Available from: http://www.tndui.com/fieldtest.html.[20 Dec, 05].

35. Bridges M. Standard field sobriety tests is current training enough: Criminal Justice Institute, School of Law Enforcement Supervision; 2004

36. Admissibility of horizontal gaze nystagmus evidence [Online]. Available from: http://www.ndaa.org/pdf/admissibility%20of%20hgn_april_2003.pdf. [20 Dec, 05].

37. พงษ์ศักดิ์ วัฒนา. รายงานคณะผู้เชี่ยวชาญสุราที่เกี่ยวข้องกับอุบัติเหตุยานยนต์. กรมการแพทย์ กระทรวงสาธารณสุข, 2536.

APPENDIX

แบบสอบถามการซักประวิติของกลุ่มตัวอย่างที่เข้าร่วมในการศึกษา

ส่วนที่ 1 ข้อมูลจากการซักประวิติ

ข้อมูลทั่วไป

1. วัน / เดือน / ปีเกิด .....

2. ท่านมีโรคประจำตัวหรือไม่

☐ ไม่มี

☐ มี (ตอบได้มากกว่า 1 ข้อ)

☐ โรคเบาหวาน

☐ โรคหัวใจ

☐ โรคไต

☐ โรคเกี่ยวกับตับ (ระบุ).....

☐ โรคความดันโลหิตสูง

☐ โรคกระเพาะอาหาร

☐ เคยผ่าตัดระบบทางเดินอาหาร (กระเพาะอาหารหรือลำไส้)

3. ขณะทำงานหรือออกกำลังกายท่านมีอาการเหนื่อยง่าย แน่นหน้าอก หายใจไม่สะดวกหรือไม่

☐ ไม่มี ☐ มี

4. ท่านเคยอาเจียนเป็นเลือดหรือถ่ายเป็นเลือดหรือไม่

☐ ไม่เคย ☐ เคย

5. ท่านเคยรับประทานยารักษาโรคเกี่ยวกับตับหรือไม่

☐ ไม่เคย ☐ เคย

6. ท่านเคยมีประวัติการรักษาโรคพิษสุราเรื้อรังหรือไม่

☐ ไม่เคย ☐ เคย

7. ปัจจุบันท่านรับประทานยาหรือไม่

☐ ไม่รับประทาน ☐ รับประทาน (ระบุ).....

ส่วนที่ 2 ผลการตรวจสุขภาพเบื้องต้น

1. น้ำหนัก.....กิโลกรัม

ส่วนสูง.....เซนติเมตร

2. ความดันโลหิต

ครั้งที่ 1.....mmHg.

ครั้งที่ 2.....mmHg.

3. มีอาการตาตัวเหลืองหรือไม่

☐ ไม่มี ☐ มี

4. มีอาการท้องโต แน่นอึดอัดท้อง แขน ขาบวมหรือไม่

☐ ไม่มี ☐ มี

หมายเหตุ

1. ขณะชั่งน้ำหนักต้องถอดรอง เอาวัตถุหรือสิ่งของที่ติดตัวออก ไม่สวมเสื้อคลุม

2. ขณะวัดส่วนสูงต้องถอดรองเท้า ขาทั้งสองข้างไม่งอ ศีรษะและลำตัวตั้งตรง

3. ก่อนจะวัดความดันโลหิตต้องนั่งหรือนอนพักอย่างน้อย 5 นาที และวัดความดันโลหิตท่านอนหงาย วัดบริเวณตำแหน่งแขนข้างใดข้างหนึ่ง

เลขที่.....

วันที่ศึกษา.....

แบบสอบถาม

การศึกษา ความน่าเชื่อถือของเครื่องมือ Standard Field Sobriety Tests

ในการทดสอบคนเมาแอลกอฮอล์

คำชี้แจง

โปรดกรอกข้อมูลและกาเครื่องหมาย √ ในช่อง □ หน้าข้อความที่เป็นจริงมากที่สุด

ส่วนที่ 1 ข้อมูลทั่วไป

1. วัน / เดือน / ปีเกิด...../...../.....
2. ที่อยู่ปัจจุบัน บ้านเลขที่..... หมู่ที่.....ชื่อบ้าน.....ตำบล.....
   อำเภอ เมือง จังหวัด บุรีรัมย์
3. สถานภาพสมรส

   □ โสด □ คู่ □ แยกกันอยู่

4.ระดับการศึกษาสูงสุด

   □ ไม่ได้เรียน □ ประถมศึกษา

   □ มัธยมศึกษาตอนต้น □ มัธยมศึกษาตอนปลาย / ปวช.

   □ อนุปริญญา / ปวส. □ ปริญญาตรี

   □ อื่นๆ ระบุ.....

5. อาชีพหลักในปัจจุบัน

   □ เกษตรกร □ รับราชการ

   □ รับจ้าง □ ค้าขาย

   □ อื่นๆ ระบุ.....

6. รายได้ของท่านต่อเดือน ยังไม่หักรายจ่าย (ระบุ ประมาณ) บาท

   □ น้อยกว่า 3000 □ 3001 – 5000

   □ 5001 – 7000 □ 7001 – 10000

   □ มากกว่า 10000

7. ประเภทของยานพาหนะที่ขับขี่

□ไม่มี

□ รถจักรยานยนต์

□ รถยนต์

ส่วนที่ 2 ประวัติการดื่มสุรา

1. ท่านเริ่มดื่มเครื่องดื่มแอลกอฮอล์ครั้งแรกตั้งแต่อายุเท่าใด เริ่มดื่มเมื่ออายุ.....ปี

2. ปัจจุบันท่านยังดื่มเครื่องดื่มแอลกอฮอล์อยู่หรือไม่

□ ไม่ดื่ม □ ดื่ม

3. ในรอบ 1 ปีที่ผ่านมาท่านดื่มเครื่องดื่มแอลกอฮอล์หรือไม่

□ ไม่ดื่ม □ ดื่ม

4. ในรอบ 1 เดือนที่ผ่านมา ท่านดื่มเครื่องดื่มแอลกอฮอล์บ่อยแค่ไหน

□ 3-4 ครั้ง / สัปดาห์

□ 1-2 ครั้ง / สัปดาห์

□ น้อยกว่า 1 ครั้ง / สัปดาห์

5. ในรอบ 1 เดือนที่ผ่านมา ท่านดื่มเครื่องดื่มแอลกอฮอล์อย่างไร (ตอบได้มากกว่าหนึ่งข้อ)

□ สุราขาว ครั้งละประมาณ_____ก๊ก / แก้ว / ขวด

□ เบียร์ ครั้งละประมาณ_____กระป๋อง / ขวด

□ แม่โขง ครั้งละประมาณ_____แบน / ขวด

□ หงษ์ทอง ครั้งละประมาณ_____แบน / ขวด

□ แสงโสม ครั้งละประมาณ_____แบน / ขวด

□ สาโท ครั้งละประมาณ_____แก้ว

□ ไวน์ ครั้งละประมาณ_____แก้ว / ขวด

□ อื่นๆ (ระบุ) .....

ส่วนที่ 3 ข้อมูลเกี่ยวกับสุขภาพ

1. ท่านมีปัญหาเกี่ยวกับ สายตา ดังต่อไปนี้หรือไม่

ความผิดปกติ	มี	ไม่มี
สายตายาว		
สายตาสั้น		
ตาบอดสี		
เคยได้รับการผ่าตัดบริเวณ ดวงตาข้างใดข้างหนึ่ง		

2. ท่านเคยได้รับการผ่าตัดบริเวณ ขา หรือหัว เข่าหรือไม่

□ ไม่มี □ มี

ส่วนที่ 4 ผลการตรวจระดับแอลกอฮอล์ทางลมหายใจ

ผลการตรวจระดับแอลกอฮอล์ทางลมหายใจ .....mg%

ลงชื่อ.....ผู้ทดสอบ

ส่วนที่ 5 ผลการทดสอบ Breath Analyzer Test and Standard Field Sobriety Tests

1. Horizontal Gaze Nystagmus (HGN) คะแนนเต็ม 6 คะแนน

เวลาที่เริ่มทำการทดสอบ.....น.เวลาที่สิ้นสุดการทดสอบ.....

การสังเกต	**ผลการทดสอบ**	
	ตาซ้าย	ตาขวา
1. การเกร็งกระตุกเมื่อเพ่งมองตามสิ่งเร้า		
2. การเกร็งกระตุกของตา เมื่อเคลื่อนสิ่งเร้าไปด้านข้างในระยะห่างที่สุด		
3. การสังเกตมุมของการเกร็งของตาที่น้อยกว่า 45 องศา		
รวมคะแนน		
คะแนนรวม		

2. Walk and Turn Test คะแนนเต็ม 8 คะแนน

เวลาที่เริ่มทำการทดสอบ.....น.เวลาที่สิ้นสุดการทดสอบ.....

การสังเกต	จำนวน(ครั้ง)	
ส่วนที่ 1 Instruction stage		
1. ไม่สามารถยืนทรงตัวได้ขณะฟังคำอธิบายและการสาธิต		
2. เดินก่อนผู้ทดสอบจะออกคำสั่ง		
ส่วนที่ 2 Balance and Counting stage	ขาไป	ขากลับ
1. มีการหยุดเดิน ขณะที่ทดสอบ		
2. ปลายเท้าไม่ชิดกับส้นเท้า (ระยะห่างมากกว่า 1 นิ้วครึ่ง)		
3. เท้าออกนอกเส้นตรงที่กำหนดทั้งเท้า		
4. ยกแขนขึ้นเพื่อทรงตัวห่างจากลำตัว มากกว่า 6 นิ้ว		
5. ทรงตัวไม่อยู่ ก้าวเท้าออกไปจากเส้นที่กำหนดทั้งสองก้าว ขณะหมุนตัวกลับ		
6. ออกเสียงนับก้าวผิด		
7. ไม่สามารถทดสอบวิธีนี้ได้		
รวมคะแนน		
คะแนนรวม		

หมายเหตุ

* ผู้ถูกทดสอบ จะได้คะแนนเต็ม 8 ในกรณีที่ ก้าวเท้าออกนอกเส้น มากกว่า 3 ครั้ง หรือทำไม่ได้

3. One Leg Stand Test คะแนนเต็ม 4 คะแนน

เวลาที่เริ่มทำการทดสอบ.....น.เวลาที่สิ้นสุดการทดสอบ.....

การสังเกต	จำนวน(ครั้ง)		
	0-10	11-20	21-30
1. เมื่อเริ่มทดสอบ แล้วมีการเซหรือทรงตัวไม่อยู่			
2. ยกแขนขึ้นเพื่อทรงตัวห่างจากลำตัว มากกว่า 6 นิ้ว			
3. ยกเท้าลงแตะพื้น			
4. กระโดดเพื่อทรงตัว			
5. ไม่สามารถทดสอบวิธีนี้ได้			
รวมคะแนน			
คะแนนรวม			

หมายเหตุ

* ผู้ถูกทดสอบจะได้คะแนนเต็มในกรณี

1. วางเท้าลงพื้น มากกว่า 3 ครั้ง ในระยะ 30 วินาที
2. ไม่สามารถทดสอบได้

แบบยินยอมเข้าร่วมการทำวิจัย

การวิจัยเรื่อง ความน่าเชื่อถือของเครื่องมือ Standard Field Sobriety Tests ในการทดสอบคนเมาแอลกอฮอล์

วันให้ความยินยอม วันที่.....เดือน.....พ.ศ.....

ข้าพเจ้า..... อายุ.....ปี

ที่อยู่ปัจจุบันบ้านเลขที่.....หมู่ที่.....ตำบล.....อำเภอเมือง จังหวัดบุรีรัมย์

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับการอธิบายจากผู้วิจัย ถึงจุดประสงค์ของการวิจัย วิธีการวิจัย อันตรายหรืออาการที่อาจเกิดขึ้นจากการวิจัย รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัยอย่างละเอียดและมีความเข้าใจดีแล้ว

ผู้วิจัยได้ตอบคำถามต่างๆที่ข้าพเจ้าสงสัยด้วยความเต็มใจไม่ปิดบังซ่อนเร้นจนข้าพเจ้าพอใจ

ข้าพเจ้ามีสิทธิ์ที่จะบอกเลิกการเข้าโครงการวิจัยนี้เมื่อใดก็ได้ การเข้าร่วมโครงการวิจัยนี้เป็นไปด้วยความสมัครใจ การบอกเลิกการเข้าร่วมโครงการวิจัยนี้จะไม่มีผลใดๆต่อข้าพเจ้า

ข้าพเจ้าได้รับทราบจากผู้วิจัยว่า จะไม่เปิดเผยข้อมูลหรือผลการวิจัยของข้าพเจ้าเป็นรายบุคคลต่อสารธารณชน และจะเปิดเผยได้เฉพาะในรูปที่เป็นบทสรุปผลการวิจัย หรือการเปิดเผยข้อมูลต่อผู้ที่มีหน้าที่เกี่ยงข้องกับการสนับสนุนและกำกับดูแลการวิจัย

ข้าพเจ้าได้รับทราบและได้ซักถามผู้วิจัยจนหมดข้อสงสัยโดยตลอดแล้วและยินดีเข้าร่วมในการวิจัย จึงได้ลงลายมือชื่อไว้เป็นหลักฐานต่อหน้าพยาน

ลงชื่อ..... ผู้ยินยอม

(.....)

ลงชื่อ.....พยาน

(.....)

ลงชื่อ.....พยาน

(.....)

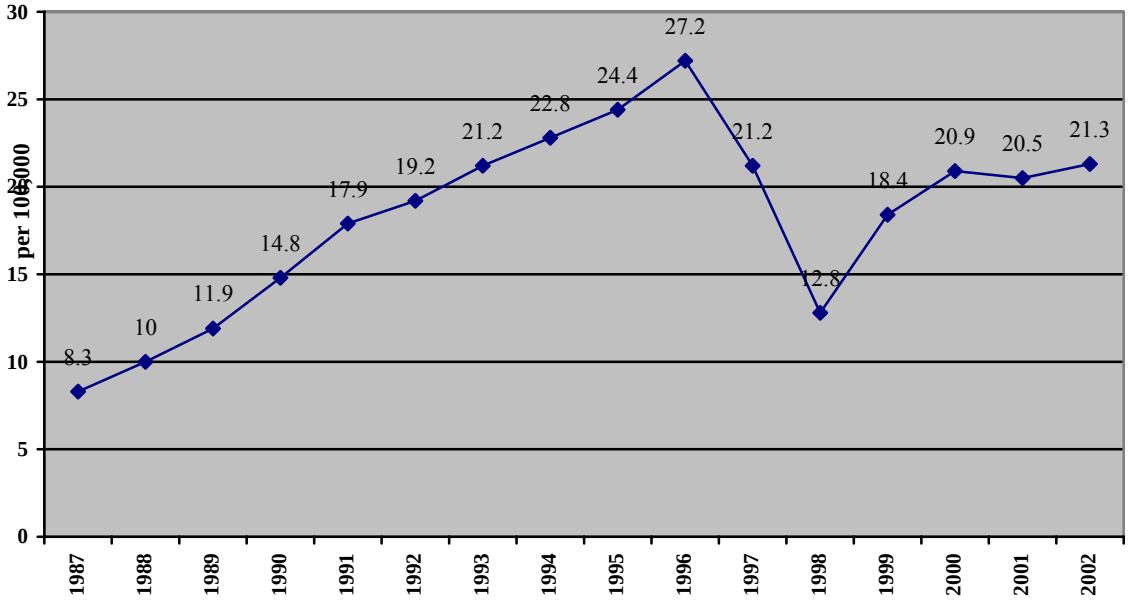

Figure 11 Mortality rate of traffic accident per 100,000 persons in Thailand during 1987- 2002

Source: Injury surveillance system, epidemiology bureau, prevention of disease department, ministry of public health, Thailand

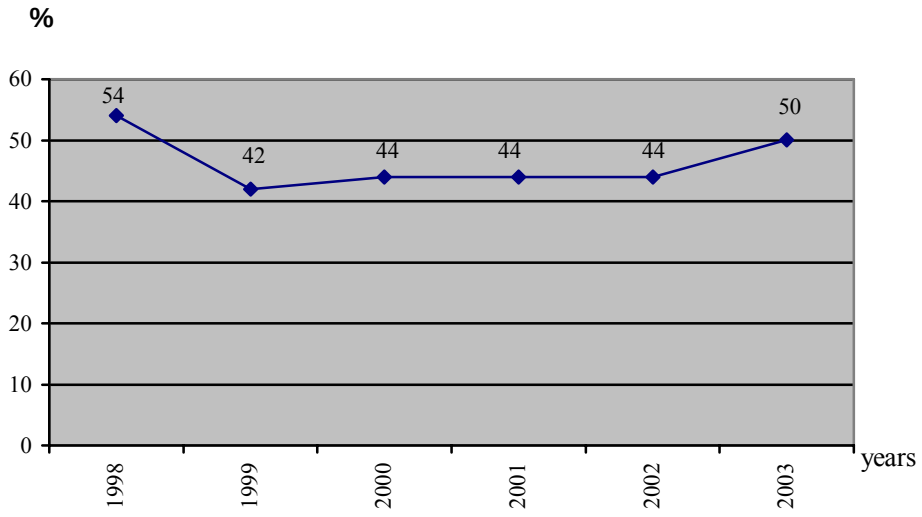

Figure 12 Percentage of drunk driving of severe injury motorist in Thailand during 1998-2003

Source: Injury surveillance system, epidemiology bureau, prevention of disease department, ministry of public health, Thailand

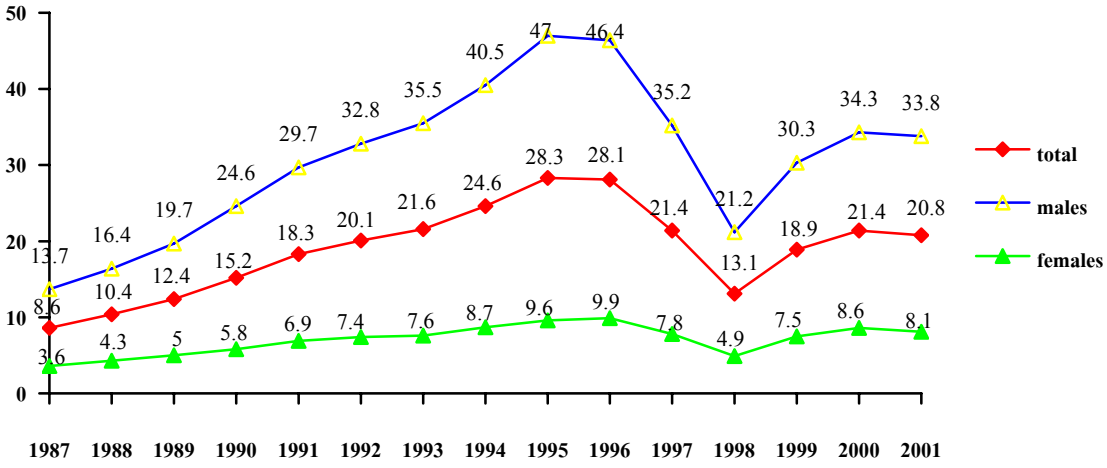

Figure 13 Trend of mortality rate from traffic accident per 100,000 by sex in Thailand during 1987-2001

Source: Bureau of health policy and plan, ministry of public health, Thailand

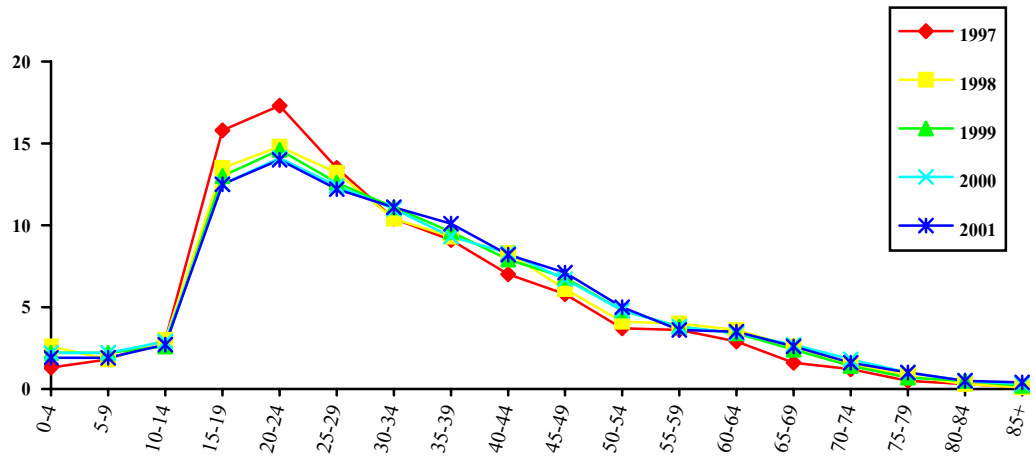

Figure 14 Mortality rate of traffic accident by age group in Thailand during 1997-2001

Source: Bureau of health policy and plan, ministry of public health, Thailand

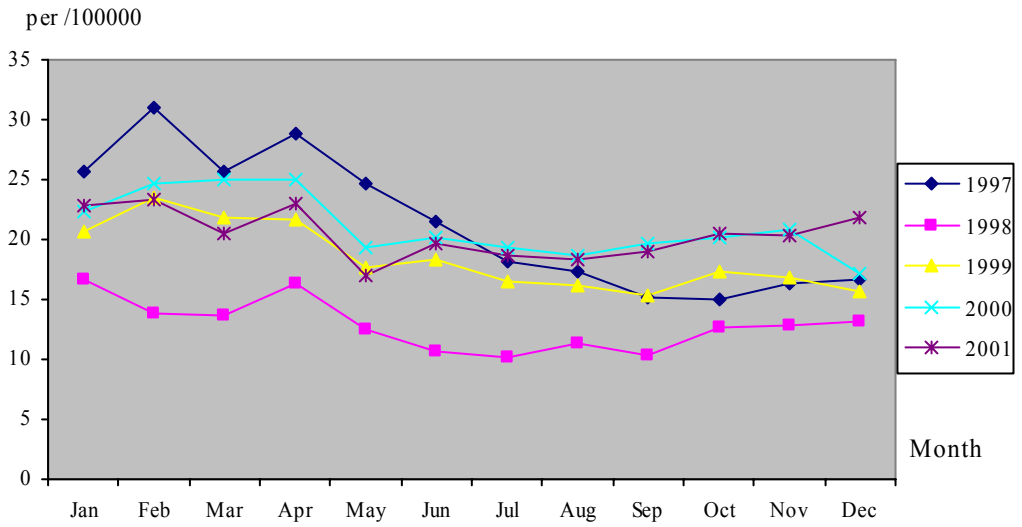

Figure 15 Mortality rate from motor vehicle traffic accident per 100000 by month in Thailand during 1997-2001

Source: Bureau of health policy and plan, ministry of public health, Thailand

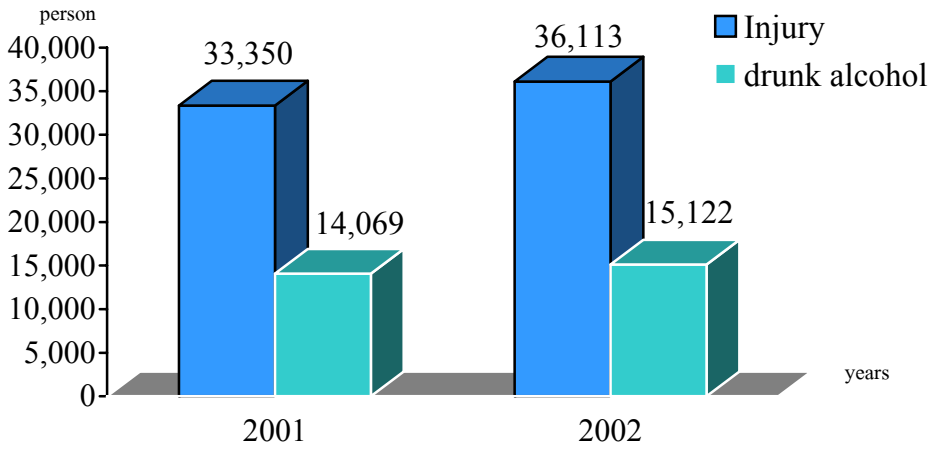

Figure 16 Number of injury and drunk alcohol patients from traffic accident

Source: Epidemiological surveillance report, December 19, 2003, epidemiology bureau, public health ministry

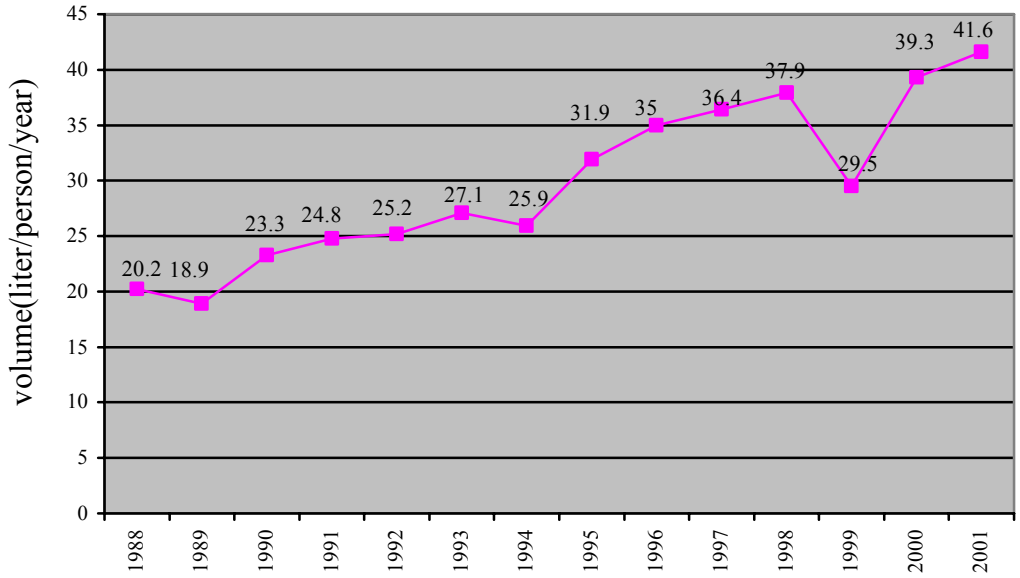

Figure 17 Trend of alcohol consumption in Thailand during 1988-2001

Source : The excise department, ministry of finance

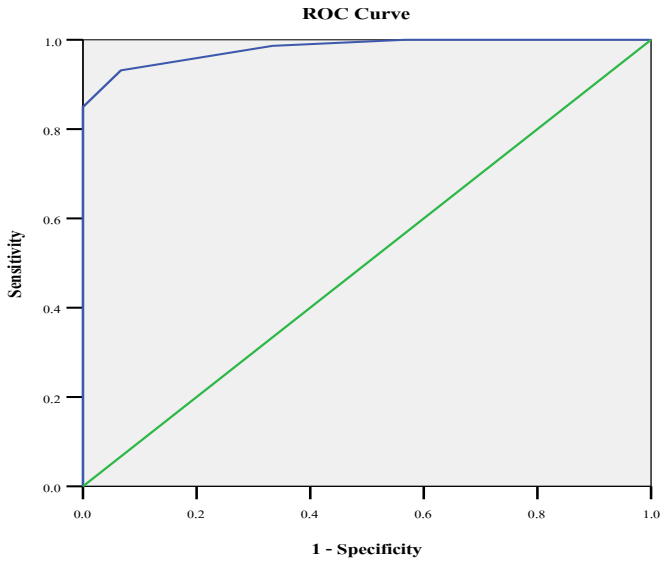

Figure 18 ROC curve of horizontal gaze nystagmus test score = 1

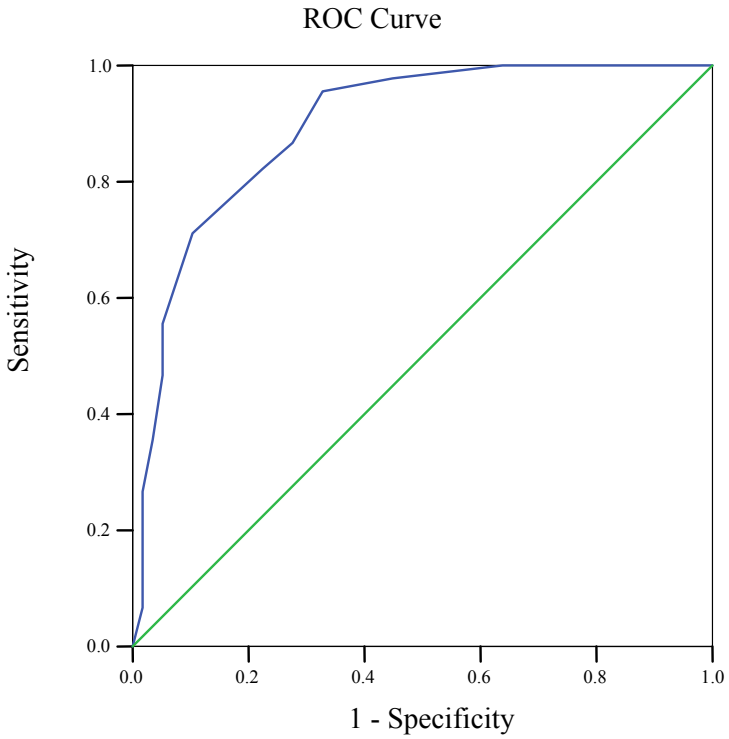

Figure 19 ROC curve of horizontal gaze nystagmus test score = 2

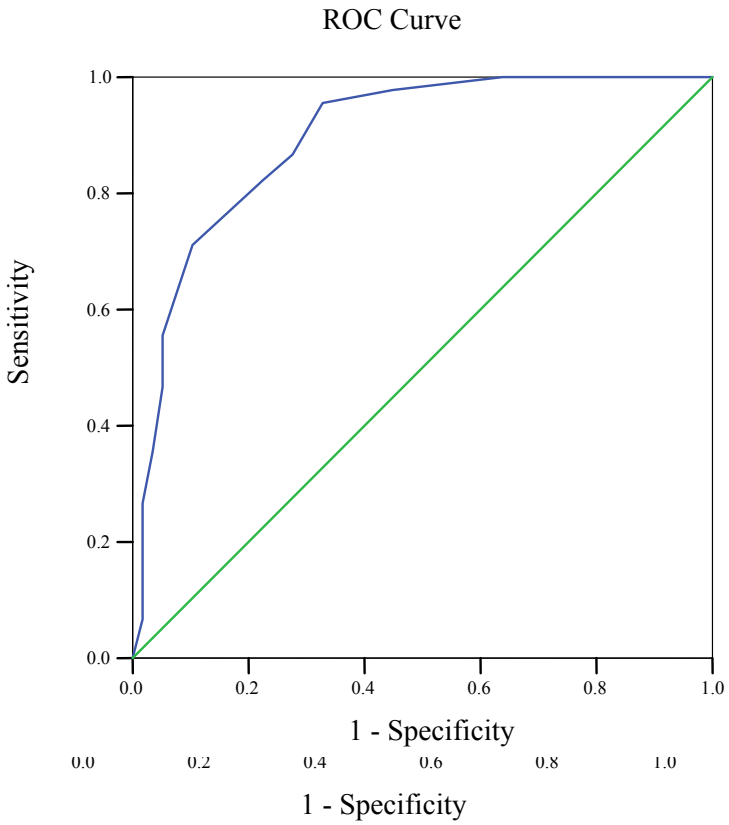

Figure 20 ROC curve of horizontal gaze nystagmus test score = 3

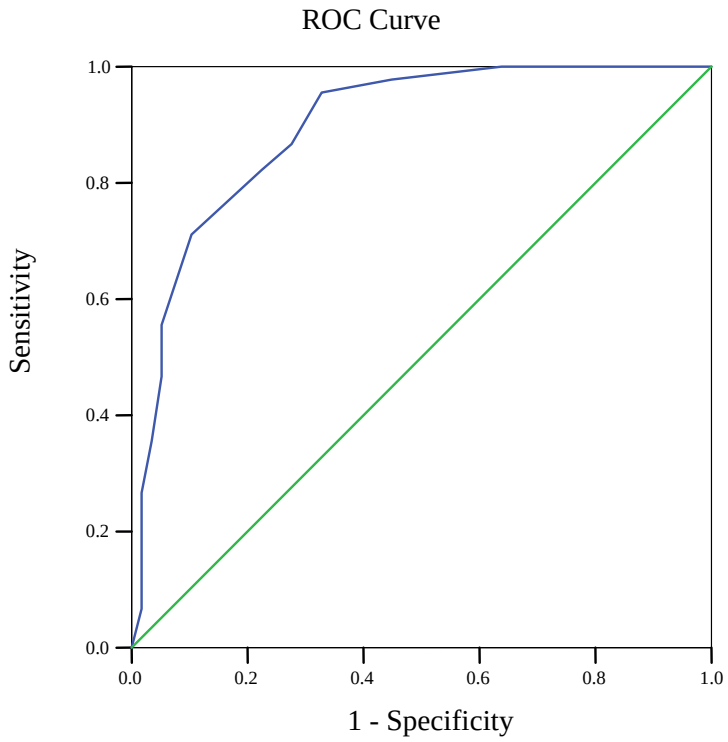

Figure 21 ROC curve of horizontal gaze nystagmus test score = 4

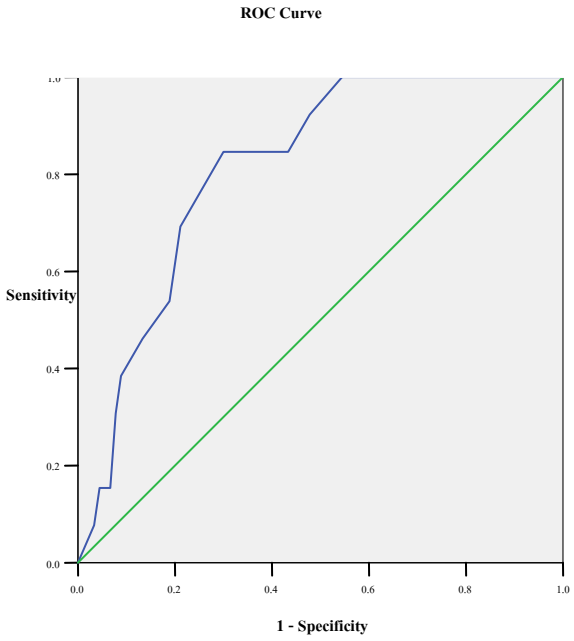

Figure 22 ROC curve of horizontal gaze nystagmus test score = 5

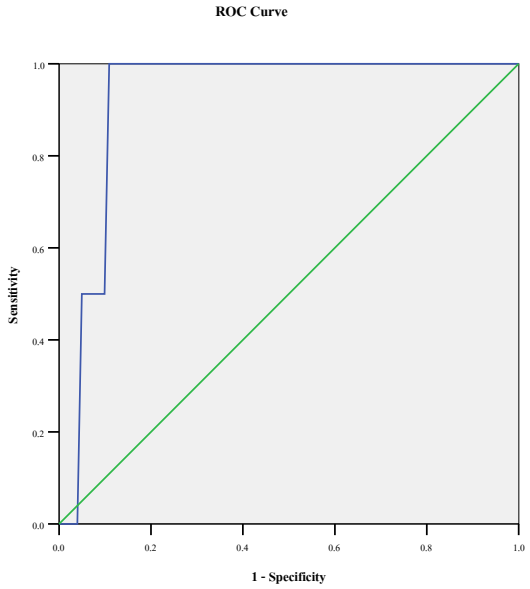

Figure 23 ROC curve of horizontal gaze nystagmus test score = 6

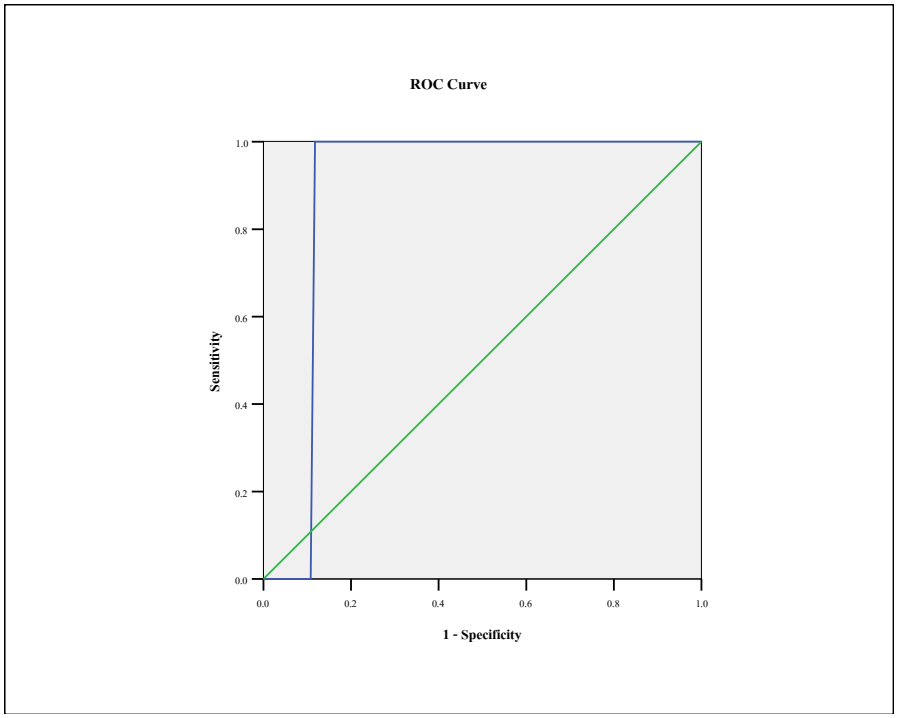

Figure 24 ROC curve of walk and turn test score = 1

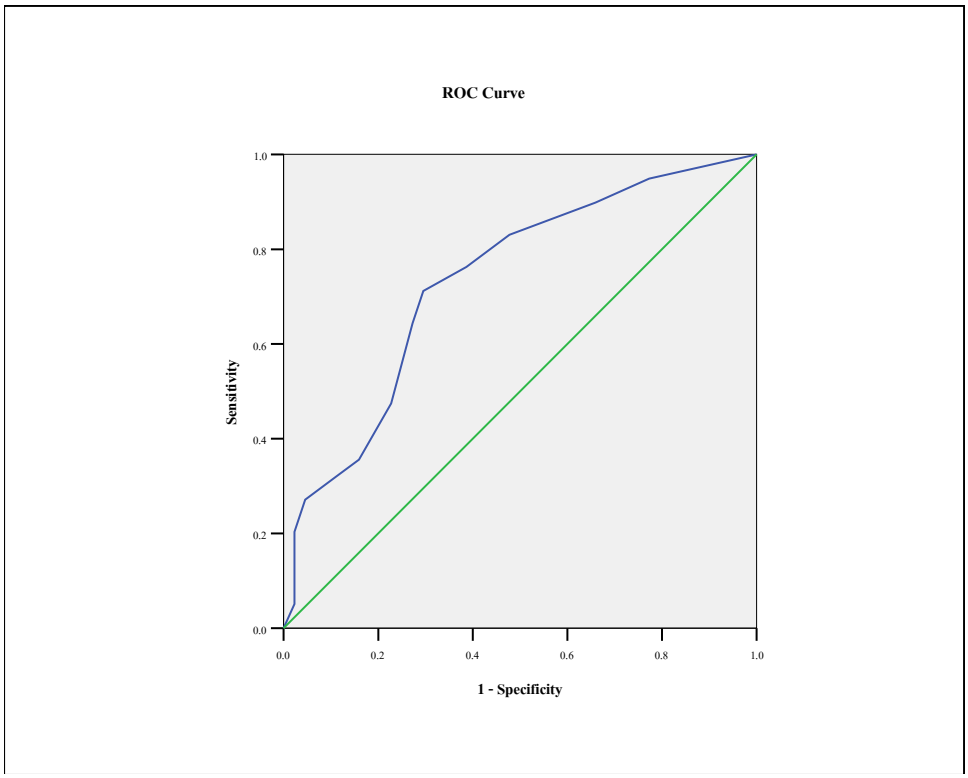

Figure 25 ROC curve of walk and turn test score = 2

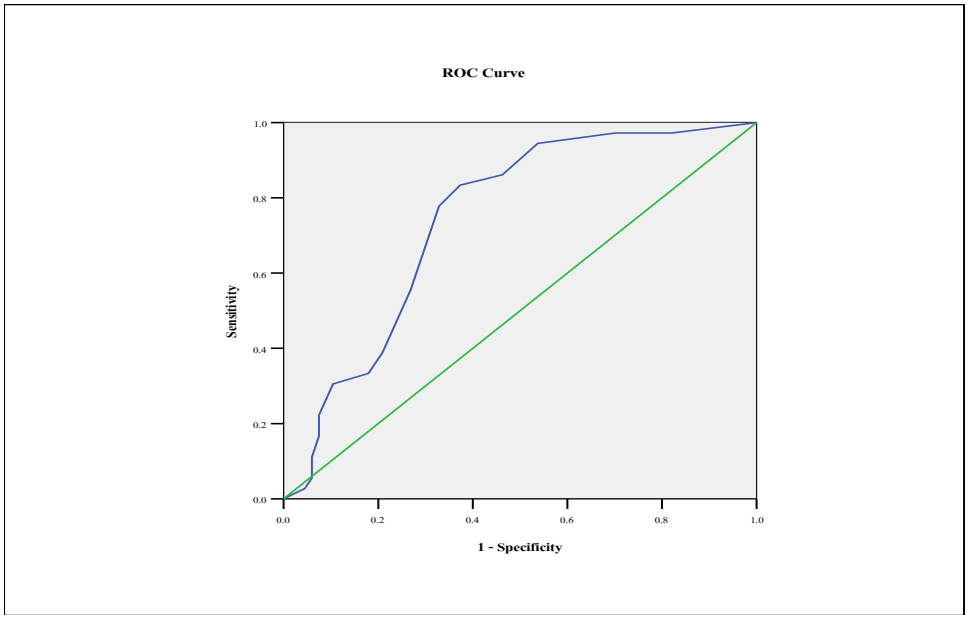

Figure 26 ROC curve of walk and turn test score = 3

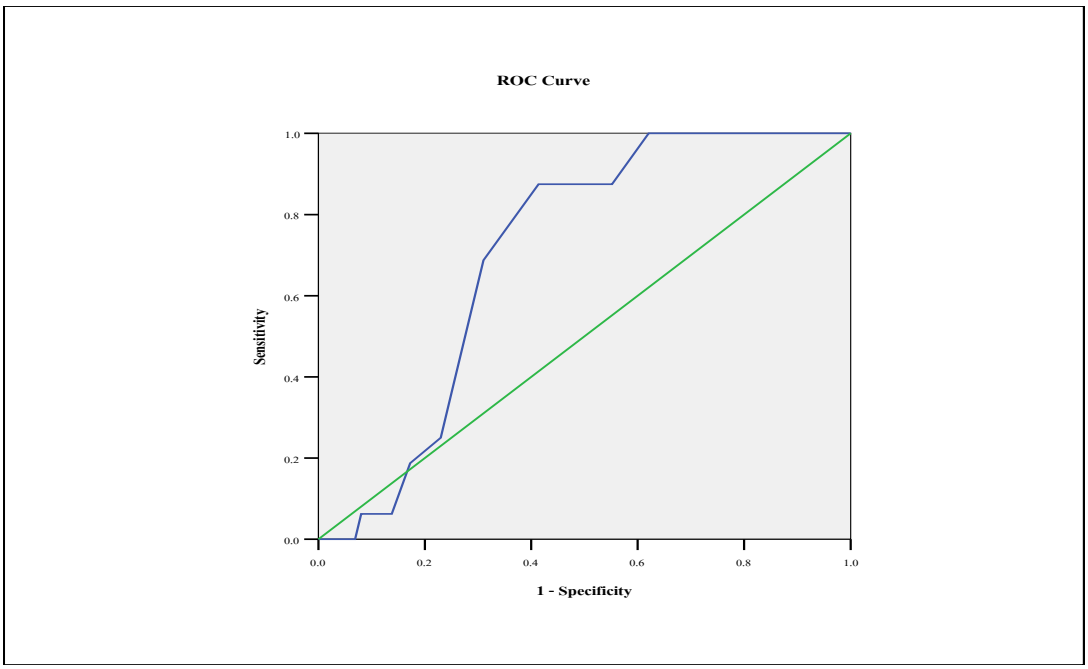

Figure 27 ROC curve of walk and turn test score = 4

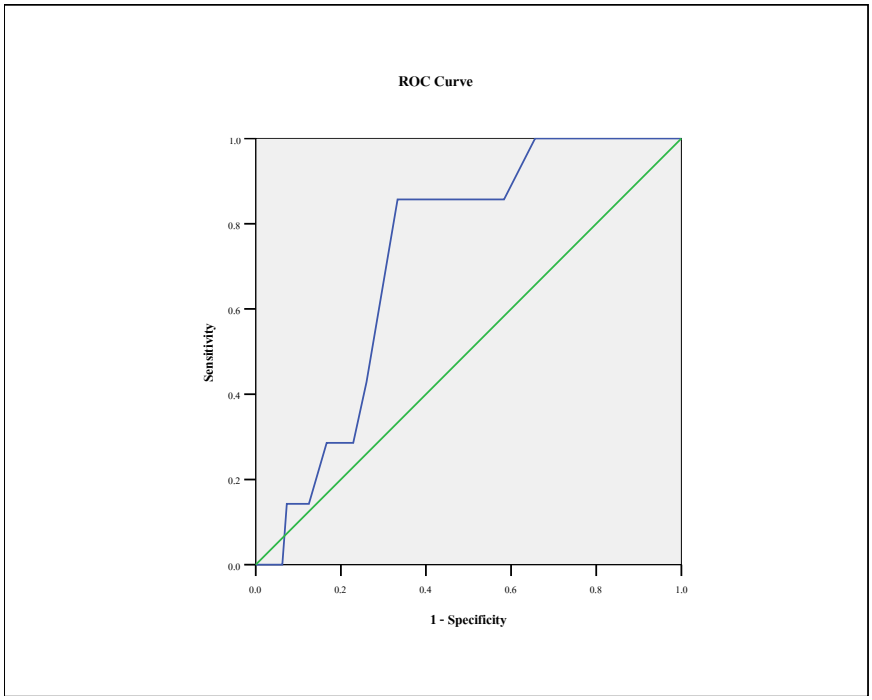

Figure 28 ROC curve of walk and turn test score = 5

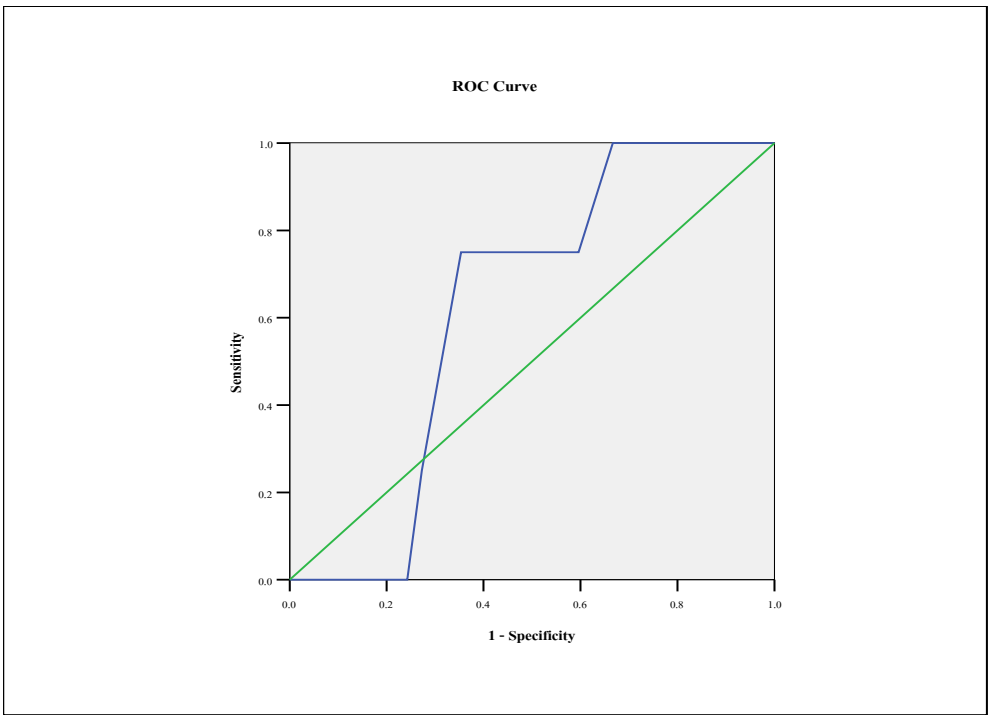

Figure 29 ROC curve of walk and turn test score = 6

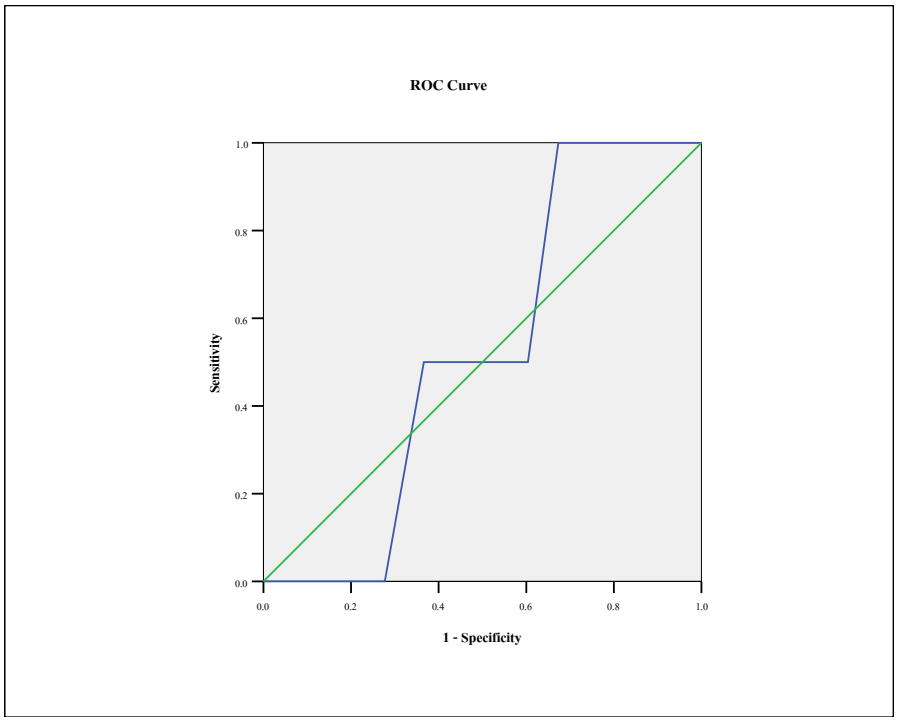

Figure 30 ROC curve of one leg stand test score = 1

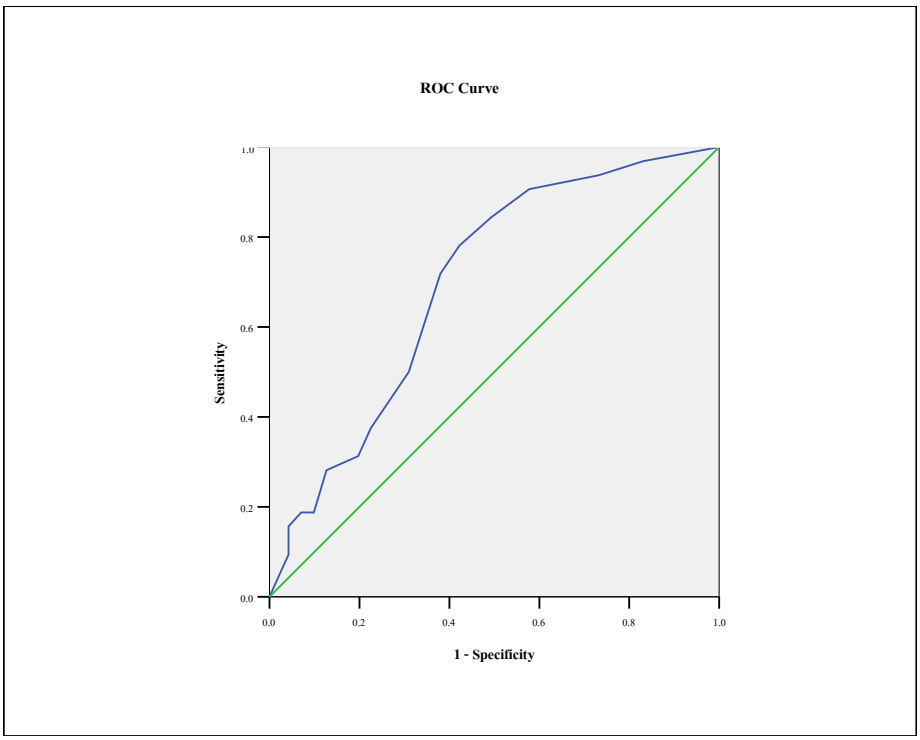

Figure 31 ROC curve of one leg stand test score = 2

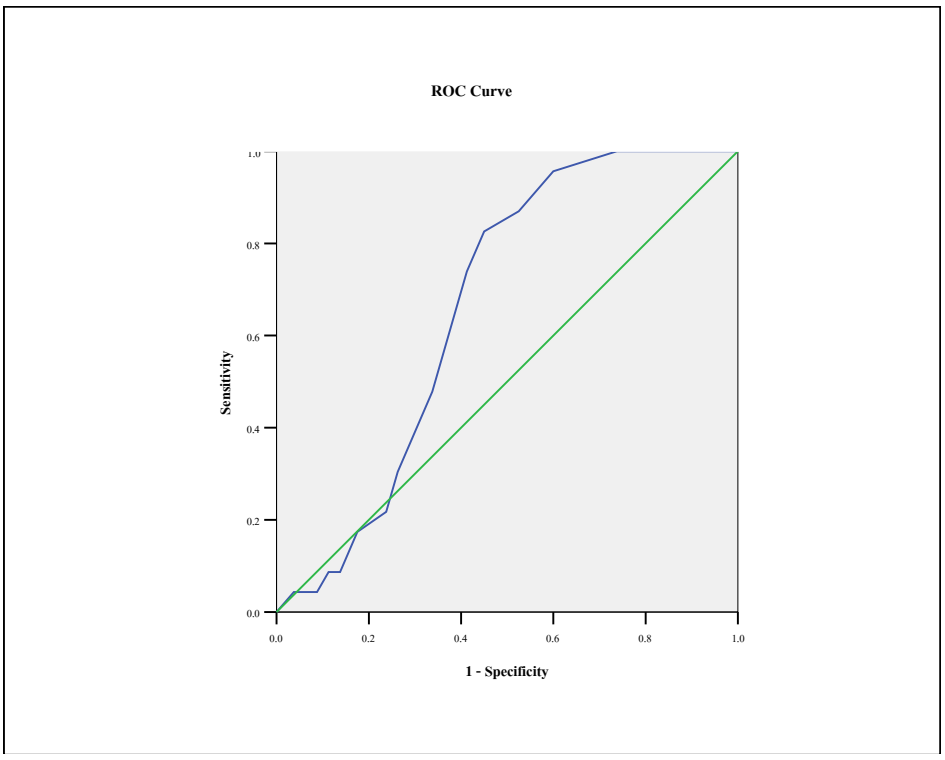

Figure 32 ROC curve of one leg stand test score = 3

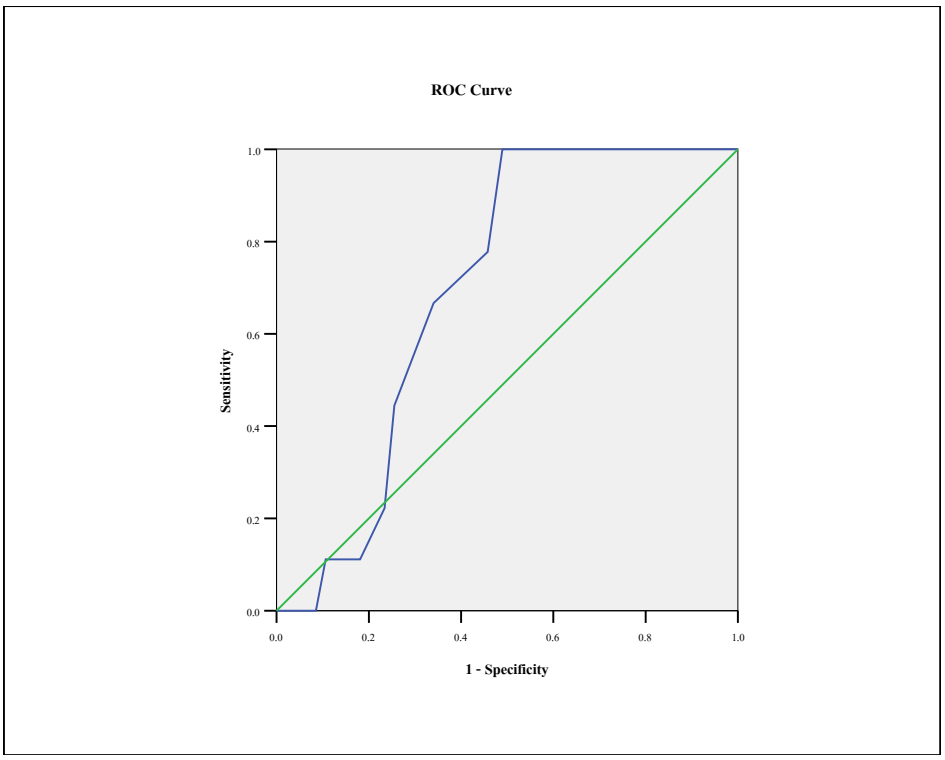

Figure 33 ROC curve of one leg stand test score = 4

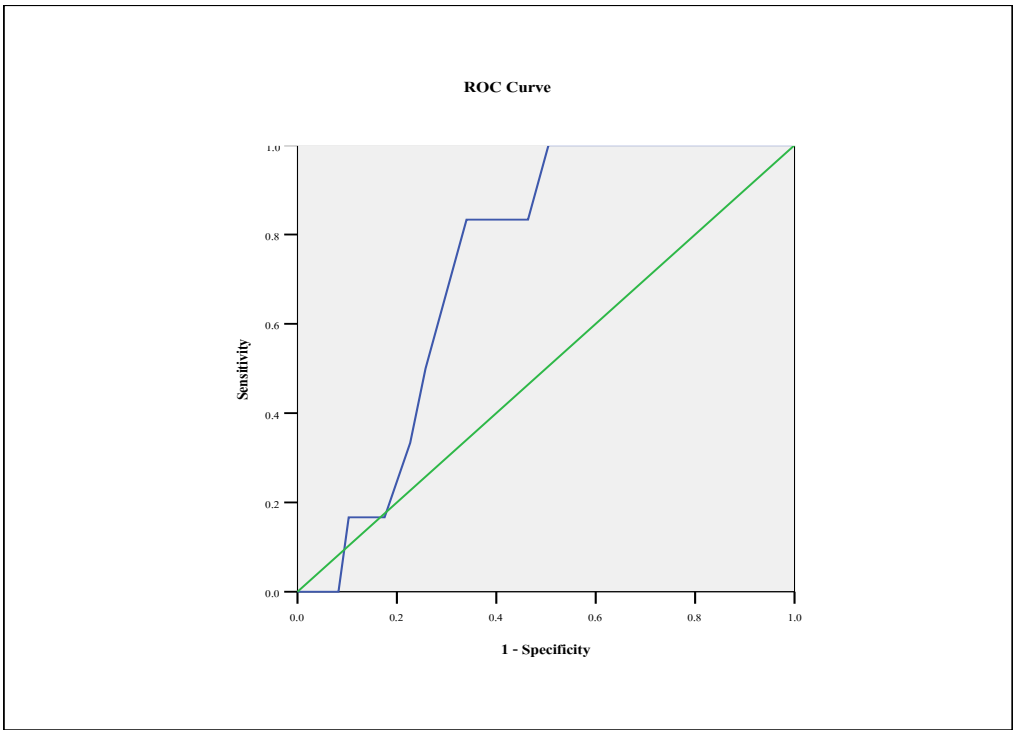

Figure 34 ROC curve of one leg stand test score = 5

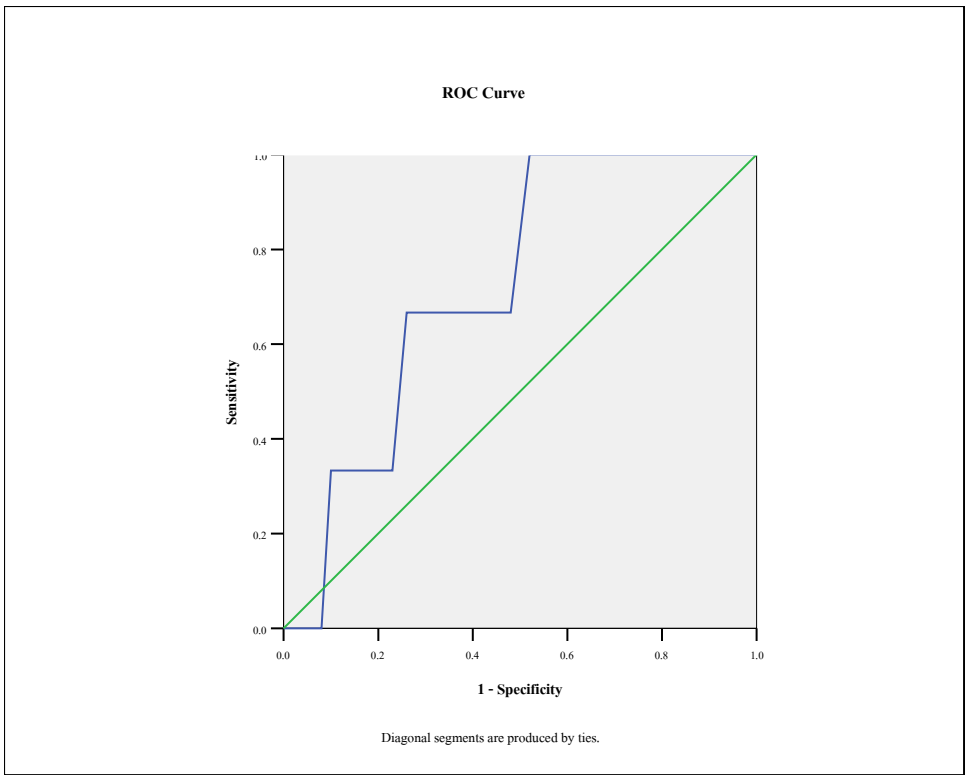

Figure 35 ROC curve of one leg stand test score = 6

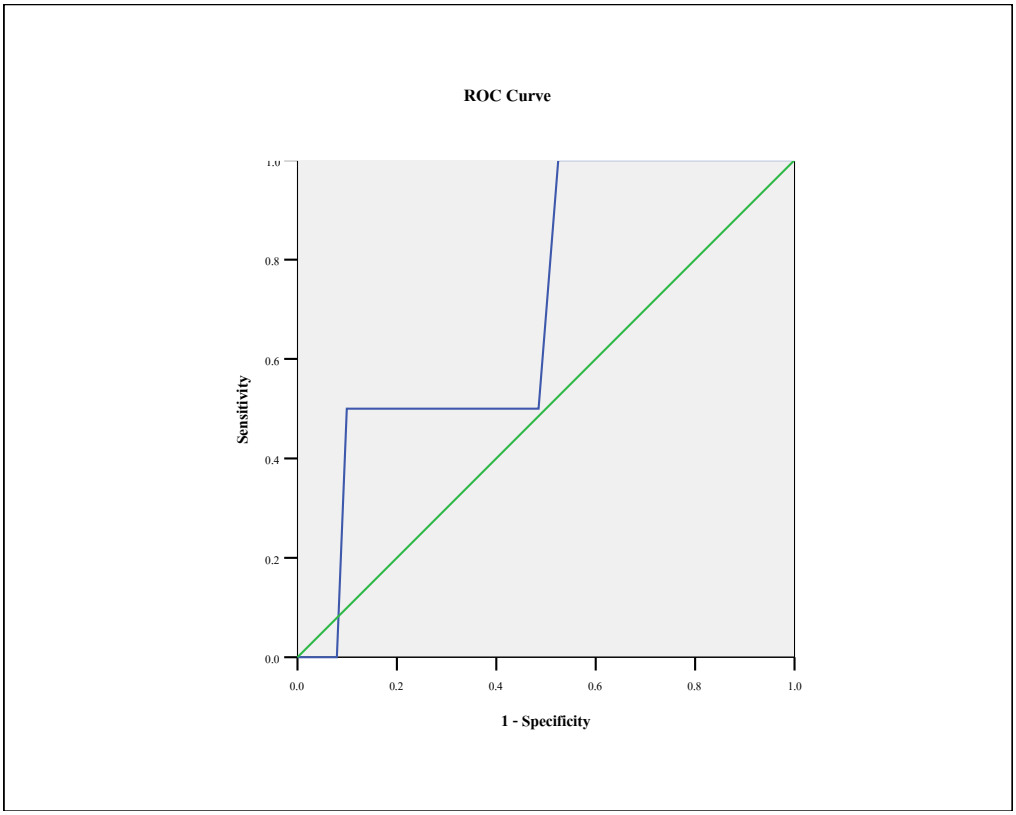

Table 15 Validity of HGN classify by BAC category

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
1	10	81.1	100	100	43.3	83.5	0.520
	20	87.8	95.2	98.6	66.7	89.3	0.716
	30*	97.1	84.8	93.2	93.3	93.2	0.840
	40	100	73.2	84.9	100	89.3	0.767
	50	100	62.5	75.3	100	82.5	0.640
	60	100	56.6	68.5	100	77.7	0.559
	70	100	46.2	52.1	100	66.0	0.387
	80	100	40.0	38.4	100	56.3	0.266
	90	100	38.0	32.9	100	52.4	0.222
	100	100	35.5	24.7	100	46.6	0.160
	110	100	33.3	17.8	100	41.7	0.112
	120	100	32.6	15.1	100	39.8	0.094
	130	100	31.6	11.0	100	36.9	0.067
	140	100	30.9	8.2	100	34.9	0.050
	150	100	30.3	5.5	100	33.0	0.033
2	10	50.0	100	100	22.4	56.3	0.202
	20	54.9	100	100	36.2	64.1	0.332
	30	62.9	97.0	97.8	55.2	73.8	0.498
	40	69.4	95.1	95.6	67.2	79.61	0.602
	50	70.9	87.5	86.7	72.4	78.7	0.576
	60	74.0	84.9	82.2	77.6	79.6	0.591
	70*	84.2	80.0	71.1	89.7	81.6	0.618
	80	89.3	73.3	55.6	94.8	77.7	0.526
	90	87.5	69.6	46.7	94.8	73.8	0.438
	100	88.9	65.9	35.6	96.6	69.9	0.344
	110	92.3	63.3	26.7	98.3	70.0	0.271

Table 15 Validity of HGN classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	120	90.9	62.0	22.2	98.3	65.0	0.224
	130	87.5	60.0	15.6	98.3	62.1	0.152
	140	83.3	58.8	11.1	98.3	60.2	0.104
	150	75.0	57.6	6.7	98.3	58.3	0.055
3	10	26.7	100	100	16.5	35.9	0.084
	20	29.3	100	100	26.6	43.7	0.144
	30	34.3	100	100	41.8	55.3	0.251
	40	38.7	100	100	51.9	63.1	0.335
	50	41.8	97.9	95.8	59.5	68.0	0.382
	60	44.0	96.2	91.7	64.6	70.9	0.408
	70	57.9	96.9	91.7	79.9	82.5	0.594
	80*	64.3	92.0	75.0	87.3	84.5	0.589
	90	62.5	88.6	62.5	88.6	82.5	0.511
	100	72.2	87.1	54.2	93.7	84.5	0.527
	110	84.6	85.6	45.8	97.5	85.4	0.515
	120	81.8	83.7	37.5	97.5	83.5	0.431
	130	87.5	82.1	29.2	98.7	82.5	0.363
	140	83.3	80.4	20.8	98.7	80.6	0.265
	150	75.0	78.8	12.5	98.7	78.6	0.158
4	10	14.4	100	100	14.4	25.2	0.041
	20	15.9	100	100	23.3	33.0	0.071
	30	18.6	100	100	36.7	45.6	0.128
	40	21.0	100	100	45.6	52.4	0.174
	50	21.8	97.9	92.3	52.2	57.3	0.187
	60	22.0	96.2	84.6	56.7	60.2	0.186
	70	28.9	96.9	84.6	70.0	71.8	0.300

Table 15 Validity of HGN classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	80*	32.1	94.7	69.2	87.4	77.7	0.322
	90	29.2	92.4	53.8	81.1	77.7	0.257
	100	33.3	91.8	46.2	86.7	81.6	0.282
	110	38.5	91.1	38.5	91.1	94.2	0.296
	120	36.4	90.2	30.8	92.2	84.5	0.246
	130	25.0	88.4	15.4	93.3	83.5	0.104
	140	33.3	88.7	15.4	95.6	85.4	0.142
	150	25.0	87.9	7.7	87.4	85.4	0.062
5	10	2.2	100	100	12.9	14.6	0.006
	20	2.4	100	100	20.8	22.3	0.010
	30	2.9	100	100	32.7	34.0	0.018
	40	3.2	100	100	40.6	41.7	0.026
	50	3.6	100	100	47.5	48.5	0.034
	60	4.0	100	100	52.5	53.4	0.041
	70	5.3	100	100	64.4	65	0.066
	80	7.1	100	100	74.3	74.8	0.101
	90	8.3	100	100	72.2	78.6	0.122
	100	11.1	100	100	84.2	84.5	0.171
	110*	15.4	100	100	89.1	89.3	0241
	120	9.1	98.9	50.0	90.1	89.3	0.125
	130	12.5	98.9	50.0	89.1	92.2	0.174
	140	16.7	99.0	50.0	95.0	94.2	0.228
	150	0.0	98.0	0.0	96.0	94.2	-0.027
6	10	1.1	100	100	12.7	13.6	0.003
	20	1.2	100	100	20.6	21.4	0.005
	30	1.4	100	100	32.4	33.0	0.009

Table 15 Validity of HGN classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	40	1.6	100	100	40.2	40.8	0.013
	50	1.8	100	100	47.1	47.6	0.017
	60	2.0	100	100	52.0	52.4	0.021
	70	2.6	100	100	63.7	64.1	0.033
	80	3.6	100	100	73.5	73.8	0.051
	90	4.2	100	100	77.5	77.7	0.063
	100	5.6	100	100	83.3	83.5	0.088
	110*	7.7	100	100	88.2	88.3	0.127
	120	0.0	98.9	0.0	89.2	88.3	-0.018
	130	0.0	98.9	0.0	92.2	91.3	-0.018
	140	0.0	99.0	0.0	94.1	93.2	-0.017
	150	0.0	99.0	0.0	96.1	95.1	-0.016

Table 16 Validity of WAT classify by BAC category

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
1	10	62.2	76.9	94.9	22.7	64.1	0.194
	20	64.6	71.4	89.8	34.1	66.0	0.256
	30	70.0	69.7	83.1	52.3	69.9	0.365
	40	72.6	65.9	76.3	61.4	69.9	0.380
	50*	76.4	64.6	71.2	70.5	70.9	0.412
	60	76.0	60.4	64.4	72.7	68.0	0.362
	70	73.7	52.3	47.5	77.3	60.2	0.233
	80	75.0	49.3	35.6	84.1	63.1	0.181
	90	79.2	49.4	32.2	88.6	56.3	0.189
	100	88.9	49.4	27.1	95.5	56.3	0.202

Table 16 Validity of WAT classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	110	92.3	47.8	20.3	97.7	53.4	0.159
	120	90.9	46.7	16.9	97.7	51.5	0.129
	130	87.5	45.3	11.9	97.7	48.5	0.084
	140	83.3	44.3	8.5	97.7	46.6	0.054
	150	75	43.4	5.1	97.7	44.7	0.024
2	10	38.9	92.3	97.2	17.9	45.6	0.112
	20	42.7	95.2	97.2	29.9	53.4	0.209
	30	48.6	93.9	94.4	46.3	63.1	0.334
	40	50.0	87.8	86.1	53.7	65.0	0.341
	50	54.5	87.5	83.3	62.7	69.9	0.410
	60	56.0	84.9	77.8	67.2	80.6	0.412
	70	52.6	75.4	55.6	73.1	67.0	0.283
	80	50.0	70.7	38.9	79.1	78.6	0.190
	90	50.0	69.9	33.3	82.1	65.0	0.167
	100	61.1	70.6	30.6	89.6	68.9	0.227
	110*	61.5	68.9	22.2	92.5	68.0	0.173
	120	54.5	67.4	16.7	92.5	66.0	0.110
	130	50.0	66.3	11.1	94.0	65.0	0.063
	140	33.3	64.9	5.6	94.0	63.1	-.005
	150	25.0	64.6	2.8	95.5	63.1	-.021
3	10	17.8	100	100	14.9	28.2	0.052
	20	19.5	100	100	24.1	35.9	0.090
	30	22.9	100	100	37.9	47.6	0.160
	40	22.6	95.1	87.5	44.8	51.5	0.149
	50	25.5	95.8	87.5	52.9	58.3	0.202

Table 16 Validity of WAT classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	60	28.0	96.2	87.5	58.6	53.4	0.247
	70*	28.9	92.3	68.8	69.0	68.9	0.242
	80	21.4	86.7	37.5	74.7	68.9	0.094
	90	16.7	84.8	25.0	77.0	68.9	0.017
	100	16.7	84.7	18.8	82.8	72.8	0.014
	110	7.7	83.3	6.3	83.2	73.8	-0.082
	120	9.1	83.7	6.3	88.5	75.7	-0.060
	130	12.5	84.2	6.3	92.0	78.6	-0.023
	140	0.0	83.5	0.0	93.1	78.6	-0.093
	150	0.0	83.8	0.0	95.4	80.6	-0.066
4	10	7.8	100	100	13.5	19.4	0.021
	20	8.5	100	100	21.9	27.2	0.037
	30	10.0	100	100	34.4	38.8	0.066
	40	9.7	97.6	85.7	41.7	44.7	0.059
	50	10.9	97.9	85.7	49.0	51.5	0.083
	60	12.0	98.1	85.7	54.2	56.3	0.104
	70*	15.8	98.5	85.7	66.7	68.0	0.172
	80	10.7	94.7	42.9	74.0	71.8	0.070
	90	8.3	93.7	28.6	77.1	73.8	0.027
	100	11.1	94.1	28.6	83.3	79.6	0.069
	110	7.7	93.3	14.3	87.5	82.5	0.013
	120	9.1	93.5	14.3	89.6	84.5	0.031
	130	12.5	93.7	14.3	92.7	87.4	0.066
	140	0.0	92.8	0.0	93.8	87.4	-0.067
	150	0.0	92.9	0.0	95.8	93.2	-0.052

Table 16 Validity of WAT classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
5	10	4.4	100	100	13.1	16.5	0.012
	20	4.9	100	100	21.2	24.3	0.020
	30	5.7	100	100	33.3	35.9	0.037
	40	4.8	97.6	75.0	40.4	41.7	0.019
	50	5.5	97.9	75.0	47.5	48.5	0.032
	60	6.0	98.1	75.0	52.5	53.4	0.042
	70*	7.9	98.5	75.0	64.6	65.0	0.078
	80	3.6	96.0	25.0	72.7	70.9	-0.006
	90	0.0	94.9	0.0	75.8	72.8	-0.071
	100	0.0	95.3	0.0	81.8	78.6	-0.068
	110	0.0	95.6	0.0	86.9	83.5	-0.063
	120	0.0	95.7	0.0	88.9	85.4	-0.060
	130	0.0	95.8	0.0	91.9	88.3	-0.055
	140	0.0	95.9	0.0	93.9	90.3	-0.049
	150	0.0	96.0	0.0	96.0	92.2	-0.040
6	10	2.2	100	100	12.9	14.6	0.006
	20	2.4	100	100	20.8	22.3	0.010
	30	2.9	100	100	32.7	34.0	0.018
	40	1.6	97.6	50.0	39.6	39.8	-0.007
	50	1.8	97.9	50.0	46.5	46.6	-0.002
	60	2.0	98.1	50.0	51.5	51.5	0.001
	70*	2.6	98.5	50.0	63.4	63.1	0.014
	80	0.0	97.3	0.0	72.3	70.9	-0.038
	90	0.0	97.5	0.0	76.2	74.8	-0.037
	100	0.0	97.6	0.0	82.2	80.6	-0.036
	110	0.0	97.8	0.0	87.1	85.4	-0.035

Table 16 Validity of WAT classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	120	0.0	97.8	0.0	89.1	87.4	-0.034
	130	0.0	97.9	0.0	92.1	90.3	-0.032
	140	0.0	97.9	0.0	94.1	92.2	-0.030
	150	0.0	98.0	0.0	96.0	94.2	-0.027

Table 17 Validity of OLS classify by BAC category

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
1	10	34.4	92.3	96.9	16.9	41.7	0.092
	20	36.6	90.5	93.8	26.8	47.6	0.144
	30	41.4	90.9	90.6	42.3	57.3	0.248
	40	43.5	87.8	84.4	50.7	61.2	0.279
	50	45.5	85.4	78.1	57.7	64.1	0.300
	60*	46.0	83.0	71.9	62.0	65.0	0.293
	70	42.1	75.4	50.0	69.0	63.1	0.181
	80	42.9	73.3	37.5	77.5	65.0	0.155
	90	41.7	72.2	31.3	80.3	65.0	0.124
	100	50.0	72.9	28.1	87.3	68.9	0.176
	110	46.2	71.1	18.8	90.1	68.0	0.106
	120	54.5	71.7	18.8	93.0	69.9	0.143
	130	62.5	71.6	15.6	95.8	70.9	0.144
	140	50.0	70.1	9.4	95.8	68.9	0.066
	150	50.0	69.7	6.3	87.2	68.9	0.045
2	10	25.6	100	100	16.3	35.0	0.080
	20	28.0	100	100	26.3	42.7	0.137
	30	31.4	97.0	95.7	40.0	52.4	0.206

Table 17 Validity of OLS classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	40	32.3	92.7	87.0	47.5	56.3	0.215
	50*	34.5	91.7	82.6	55.0	62.2	0.251
	60	34.0	88.7	73.9	58.8	62.1	0.230
	70	28.9	81.5	47.8	66.3	62.1	0.114
	80	25.0	78.7	30.4	73.8	64.1	0.039
	90	20.8	77.2	21.7	76.3	64.1	-0.020
	100	22.2	77.6	17.4	82.5	68.0	-0.001
	110	15.4	76.7	8.7	86.3	68.9	-0.060
	120	18.2	77.2	8.7	88.8	70.9	-0.031
	130	12.5	76.8	4.3	91.3	71.8	-0.057
	140	16.7	77.3	4.3	93.8	73.8	-0.026
	150	25.0	77.8	4.3	96.3	75.7	0.008
3	10	10.0	100	100	13.8	21.4	0.027
	20	11.0	100	100	22.3	29.1	0.048
	30	12.9	100	100	35.1	40.8	0.086
	40	14.5	100	100	43.6	48.5	0.119
	50*	16.4	100	100	51.1	55.3	0.154
	60	14.0	96.2	77.8	54.3	56.3	0.105
	70	15.8	95.4	66.7	66.0	66	0.133
	80	14.3	93.3	44.4	74.5	71.8	0.097
	90	8.3	91.1	22.2	76.6	71.8	-0.007
	100	5.6	90.6	11.1	81.9	76.7	-0.048
	110	7.7	91.1	11.1	87.2	80.6	-0.014
	120	9.1	91.3	11.1	89.4	82.5	0.004
	130	0.0	90.5	0.0	91.5	83.5	-0.090
	140	0.0	90.7	0.0	93.6	85.4	-0.075

Table 17 Validity of OLS classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	150	0.0	90.9	0.0	95.7	87.4	-0.057
4	10	6.7	100	100	13.4	18.4	0.018
	20	7.3	100	100	21.6	26.2	0.031
	30	8.6	100	100	34.0	37.9	0.057
	40	9.7	100	100	42.3	45.6	0.079
	50	10.9	100	100	49.5	52.4	0.102
	60	10.0	98.1	83.3	53.6	55.3	0.083
	70*	13.2	98.5	83.3	66.0	67.0	0.141
	80	10.7	96.0	50.0	74.2	72.8	0.089
	90	8.3	94.9	33.3	77.3	74.8	0.044
	100	5.6	94.1	16.7	82.5	78.6	-0.004
	110	7.7	94.4	16.7	87.6	83.5	0.028
	120	9.1	94.6	16.7	89.7	85.4	0.046
	130	0.0	93.7	0.0	91.8	86.4	-0.071
	140	0.0	93.8	0.0	93.8	88.3	-0.062
	150	0.0	93.9	0.0	95.9	90.3	-0.049
5	10	3.3	100	100	13.0	15.5	0.009
	20	3.7	100	100	21.0	23.3	0.015
	30	4.3	100	100	33.0	35.0	0.028
	40	4.8	100	100	41.0	42.7	0.039
	50	5.5	100	100	48.0	49.5	0.051
	60	4.0	98.1	66.7	52.0	52.4	0.022
	70	5.3	98.5	66.7	64.0	64.1	0.046
	80	7.1	98.7	66.7	74.0	73.8	0.081
	90	4.2	97.5	33.3	77.0	75.7	0.024
	100	5.6	97.6	33.3	83.0	81.6	0.048

Table 17 Validity of OLS classify by BAC category (continued)

Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
	110	7.7	97.8	33.3	88.0	86.4	0.082
	120*	9.1	97.8	33.3	90.0	88.3	0.102
	130	0.0	96.8	0.0	92.0	89.3	-0.044
	140	0.0	96.9	0.0	94.0	91.3	-0.040
	150	0.0	97.0	0.0	96.0	93.2	-0.034.
6	10	2.2	100	100	12.9	14.6	0.006
	20	2.4	100	100	20.8	22.3	0.010
	30	2.9	100	100	32.7	34.0	0.018
	40	3.2	100	100	40.6	41.7	0.026
	50	3.6	100	100	47.5	48.5	0.034
	60	2.0	98.1	50.0	51.5	51.5	0.001
	70	2.6	98.5	50.0	63.4	63.1	0.014
	80	3.6	98.7	50.0	73.3	72.8	0.032
	90	4.2	98.7	50.0	77.2	76.7	0.043
	100	5.6	98.8	50.0	83.2	82.5	0.067
	110	7.7	98.9	50.0	88.1	87.4	0.103
	120*	9.1	98.9	50.0	90.1	89.3	0.125
	130	0.0	97.9	0.0	92.1	90.3	-0.032
	140	0.0	97.9	0.0	94.1	92.2	-0.030
	150	0.0	98.0	0.0	96.0	94.2	-0.027

Table 18 Ethnicity in SFST study during 1981 to 1997

Race	Participants (%)		
	1981	1995	1997
Caucasians	53.3	52.1	84.4
Blacks	19.0	0.7	1.6
Latin/Hispanic	17.8	13.8	3.4
Orientals/Asian	3.9	1.3	1.1
Other/unknown	3.3	32.1	9.5

Table 19 Validity of SFST at BAC cut off 50 mg%

test	Score	BAC (mg%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	kappa
HGN	1	50	100	62.5	75.3	100	82.5	0.640
	2*	50	70.9	87.5	86.7	72.4	78.7	0.576
	3	50	41.8	97.9	95.8	59.5	68.0	0.382
	4	50	21.8	97.9	92.3	52.2	57.3	0.187
	5	50	3.6	100	100	47.5	48.5	0.034
	6	50	1.8	100	100	47.1	47.6	0.017
WAT	1*	50	76.4	64.6	71.2	70.5	70.9	0.412
	2	50	54.5	87.5	83.3	62.7	69.9	0.410
	3	50	25.5	95.8	87.5	52.9	58.3	0.202
	4	50	10.9	97.9	85.7	49.0	51.5	0.083
	5	50	5.5	97.9	75.0	47.5	48.5	0.032
	6	50	1.8	97.9	50.0	46.5	46.6	-0.002
OLS	1*	50	45.5	85.4	78.1	57.7	64.1	0.300
	2	50	34.5	91.7	82.6	55.0	62.2	0.251
	3	50	16.4	100	100	51.1	55.3	0.154
	4	50	10.9	100	100	49.5	52.4	0.102
	5	50	5.5	100	100	48.0	49.5	0.051
	6	50	3.6	100	100	47.5	48.5	0.034

BIOGRAPHY

NAME	Mister Pawit Katakot
DATE OF BIRTH	17 February 1971
PLACE OF BIRTH	Buriram, Thailand
INSTITUTIONS ATTENDED	Rajabhat Buriram University, 1994-1996 Bachelor of Health Science (Education) Mahidol University, 2003-2007 Master of Science (Epidemiology)
RESEARCH GRANT	Supported in part by the Thesis Grant, Don't Drive Drunk Foundation
POSITION AND PLACE	1991- Present: Registered Technician Health officer Provincial Health office, Buriram, Thailand