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KOK CHIN NING

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DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, summaries and references, which have been duly acknowledged.

14 May 2010

Kok Chin Ning
(HN2006-3345)

CERTIFICATION

NAME	:	**KOK CHIN NING**
MATRIC NO.	:	**HN2006-3345**
TITLE	:	**NUTRITIONAL AND HEALTH STATUS OF DUSUN IN RANAU AND KUALA PENYU**
DEGREE	:	**BACHELOR OF FOOD SCIENCE WITH HONORS (FOOD SCIENCE AND NUTRITION)**
VIVA DATE	:	**12 MAY 2010**

DECLARED BY

1. SUPERVISOR

(Dr. Yasmin B. H. Ooi) (*Signature*)

2. EXAMINOR 1

(Datin Rugayah Issa) (*Signature*)

3. EXAMINOR 2

(Pn. Shalawati @ Salwa Ibrahim) (*Signature*)

4. DEAN

(Associate Professor Dr. Mohd Ismail bin Abdullah) (*Signature*)

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ABSTRACT

NUTRITIONAL AND HEALTH STATUS OF DUSUN IN RANAU AND KUALA PENYU

This study aimed to examine the difference of nutritional and health status of the Dusun between Ranau (highland area) and Kuala Penyu (coastal area). Design was cross-sectional assessment of anthropometric, biochemical, and diet from population. Subjects (61 from Ranau; 52 from Kuala Penyu; aged 30-90 years) from both areas completed a triple 24-hour dietary recall, single FFQ, and biochemical tests for serum blood glucose and lipids. Comparison of 24-hour dietary recall and FFQ data with EI/BMR ratio showed that there were more over-reporters of energy intake from FFQ than 24-hour dietary recall in both men and women. Therefore all analyses using dietary data were derived from 24-hour dietary recall. Measurements from FFQ were used to identify food groups consumed. Lifestyle factor such as smoking and alcohol consumption was significantly positive correlated ($p<0.05$) with serum lipid level, BMI, and blood pressure. Food patterns were compared with Malaysian Food Guide Pyramid recommendations. Subjects from Ranau had a higher intake of meat and poultry products compared to Kuala Penyu. Calcium, milk and dairy products intake was relatively low among subjects from both locations. Mean serum total cholesterol ($p<0.001$), serum triglycerides ($p<0.05$) and fasting blood glucose ($p<0.001$) level of subjects from Ranau was significantly higher than subjects from Kuala Penyu. Stepwise multiple linear regression analysis identified BMI as predictor of diabetes and hypercholesterolemia; age, serum triglycerides level and usage of salt per month per person (kg) as predictors of hypertension; BMI and usage of oil per month per person (kg) as predictors of hyperlipidemia.

ABSTRAK

Kajian ini bertujuan untuk mengkaji perbezaan status pemakanan dan kesihatan bagi etnik Dusun di antara Ranau (kawasan tinggi) dan Kuala Penyu (kawasan persisiran pantai). Reka bentuk kajian adalah berdasarkan taksiran keratan lintang melalui ukuran antropometrik, biokimia, dan diet daripada penduduk. Subjects (61 daripada Ranau; 52 daripada Kuala Penyu; berumur 30-90 tahun) daripada kedua-dua kawasan telah menyiapkan borong ingatan diet 24-jam, FFQ tunggal, dan ujian-ujian biokimia untuk glukosa darah dan serum lipid. Perbandingan ingatan diet 24-jam dan data FFQ dengan nisbah EI / BMR telah menunjukkan terdapat lebih subject yang melaporkan pengambilan tenaga yang berlebihan daripada FFQ berbanding dengan ingatan diet 24-jam kembali dalam kedua-dua lelaki dan perempuan. Oleh demikian, semua analisis adalah berdasarkan daripada data ingatan diet 24-jam. Data daripada FFQ digunaakan untuk mengenal pasti kumpulan makanan yang dimakan. Faktor gaya hidup seperti merokok dan pengambilan alkohol nyata sekali positif dihubung kait ($p<0.05$) dengan tahap lipid serum, BMI, dan tekanan darah. Corak makanan telah dibandingkan dengan saranan Piramid Panduan Makanan Malaysia. Pengambilan makanan daripada kumpulan makanan daging dan produk ternakan adalah lebih tinggi di kalangan subject dari Ranau. Pengambilan kalsium, susu dan hasil ternusu adalah rendah bagi kedua-dua kawasan. Min bagi jumlah kolesterol ($p<0.001$), trigliserida ($p<0.05$) dan glukosa darah berpuasa ($p<0.001$) bagi subject di Ranau adalah nyata sekali lebih tinggi daripada subject dari Kuala Penyu. Melalui analisis Stepwise Multiple Linear Regression, BMI dikenal pasti sebagai peramal kencing manis dan hypercholestrolaemia; umur, serum trigliserida dan penggunaan garam bagi seorang dalam sebulan (kg) sebagai peramal tekanan darah tinggi; BMI dan penggunaan minyak seorang dalam sebulan (kg) sebagai peramal hiperlipidemia.

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LIST OF ABBREVIATIONS

BMI	*Body Mass Index*
BMR	*Basal metabolic rate*
CHD	*Coronary heart disease*
CVD	*Carviovascular Disease*
EDTA	*Ethylene-diamine-tetra-acetic acid*
eg.	*Example*
et al.	*And others*
FFQ	*Food frequency questionnaire*
HDL	*High Density Lipoprotein*
IDF	*International Diabetic Federation*
kcal	*Kilocalories*
LDL	*Low Density Lipoprotein*
MetS	*Metabolic syndrome*
MOH	*Ministry of Health*
NCDs	*Non-communicable diseases*
RNI	*Recommended Dietary Intake*
SPSS	*Statistical Package for Social Science*
WHO	*World Health Organization*

LIST OF SYMBOLS

N	Total sample size
n	Sample size
e	Confidential level
m	Meter
mm	Millimetre
kg	Kilogram
g	Gram
mg	Milligram
L	Litre
ml	Millilitre
%	Percentage
>	More than
<	Less than
±	Plus minus
*	Multiply
-	Minus
=	Equals to
+	Plus

CHAPTER 1

INTRODUCTION

1.1 Research Background

Ranau which is a highland area situated between the West Coast Division and the Ranau District of Sabah (Website of Ranau District Office, 2007). Kuala Penyu is situated in the Interior Division, the South Western part of the state. It faces the South China Sea at the west part which is a coastal area. The Kadazandusun is the largest ethnic group in these two areas (Department of Statistics Malaysia, 2000).

A number of studies had shown that the nutritional status of the community in Sabah especially the children were found to be underweight (Foo *et al.,* 2006; Kandiah *et al.*, 1984). The nutritional status during adolescence may predict the occurrence of obesity and other diet-related chronic diseases later in life (Foo *et al.*, 2006; Sherina and Rozali, 2004). Protein deficiency and anemia was common among the women of child-bearing age (Kandiah *et al.*, 1984). The Malaysian Adult Nutrition Survey carried out among adults aged 18 years and above in 2003 also reported that there is a lower prevalence of obesity and overweight for those in Sabah compare to peninsular Malaysia. The mean BMI for Sabah is 23.70 kg/m^2 (23.31 kg/m^2 to 24.09 kg/m^2). The mean BMI of men was lower than the mean BMI for women. The difference was however not significant. However, the nutritional status of Malaysia is undergoing a nutrition transition (Khor, 2002). The findings of the Malaysian Adult Nutrition Survey (2008a) had suggested that Malaysia is facing an increasing problem of overweight and obesity among adult.

The dietary intake of Malaysian adults had been variable due to differences in geographical locations (MANS, 2008b). This statement was further supported by the study of Ahmad *et al.* (2008) which concluded that there was a significant

difference in salty food usage/intake between subjects of different geographical locations in Sabah. Besides that, Jamel *et al.* (1996) also reported that people who are living in urban areas have difference dietary intake compared to people who are living in rural area which have a less preference for sweetness. Dietary habits and intakes are one of the most important factors which influence on the occurrence of non-communicable disease (Jime'nez-Contreras *et al.*, 2005). The difference in dietary intake of the community in these two geographical areas might have lead to different health risks.

Foo *et al.* (2006) found that the community at the coastal area of Sabah such as the fishing village will have a higher source of protein from fish and seafood. Their protein intake was found to be adequate in meeting the Malaysia RNI. However, there was no specific study done to compare the nutritional status of the community from the coastal area and highland area in Sabah. The choice of location (Ranau and Kuala Penyu) was such that geographical regions which might affect food availability, therefore, possibly affect the communities' nutritional status could be investigated. This research was not only important in evaluating the nutritional status of the Dusuns, it also helped to determine their dietary habits and lifestyle in relation to non-communicable disease in order to contribute towards disease prevention.

1.2 Location of Study

The total population of Sabah in year 2000 was about 2,229,800 excluding non-Malaysian citizens. It consists of thirty different ethnic groups. The largest ethnic group in Sabah is the Kadazandusun comprising about 25.2 percent of total population (Department of Statistics Malaysia, 2000). The Kadazandusun consist of 41 dialectical ethnic groups (Tunggolou, 2004).

Ranau with the total area of 2,844 km^2 is a highland area which is situated between the West Coast Division and the Ranau District of Sabah. The word Ranau originated from the word 'Ranahon' which means paddy field. Those who live in flat terrain farm paddy in watery places or 'padi sawah' which locals called 'Ranahon' which later was translated to 'Ranau'. From the total population of

70,649 in Ranau, there are 61,227 Dusun. 26,328 are Muslim, 30,613 are Christian and 4,286 are from other religions (Website of Ranau District Office, 2007).

Kuala Penyu with the total area of 901 km^2 is situated in the Interior Division, the South Western part of the state. It faces the South China Sea at the west part which is a coastal area. From the total population of 14,271 in Kuala Penyu, there were 645 Dusun (Department of Statistics Malaysia, 1995). Their main socio-economic activities are agriculture, fish and animal livestock farming. 75% of the total population in Kuala Penyu are indirectly involved in agriculture and work as a fisherman (Department of Statistics Malaysia, 2000).

1.3 Nutritional Status and Non-communicable Diseases (NCD)

Chronic non-communicable diseases are the leading cause of death and disability worldwide and are increasing rapidly in most regions of the world. Cardiovascular diseases (CVD) are the number one cause of death globally: more people die annually from CVDs than from any other cause. An estimated 17.5 million people died from CVDs in 2005, representing 30% of all global deaths. Of these deaths, an estimated 7.6 million were due to coronary heart disease and 5.7 million were due to stroke. Over 80% of CVD deaths take place in low- and middle-income countries and occur almost equally in men and women (Website of WHO, 2009b).

Malaysia as a developing country currently is undergoing a rapid pace of socioeconomic development including industrialisation and urbanisation. There has been reduced prevalence of infectious diseases and increased prevalence of chronic non-communicable diseases (coronary heart disease, diabetes, hypertension, hyperlipidaemia) in developing countries due to nutritional changes, cultural and social development (Gill *et al.*, 2001; Nissinen *et al.*, 2001). The rapid and marked socioeconomic advancement in Malaysia has brought about significant changes in the lifestyles of communities. These included significant changes in the dietary patterns such as increased consumption of high-calorie food products and low level of physical activity (Binkley *et al.*, 2000; Tee, 1999). According to the findings of the Malaysian Adult Nutrition Survey (2007), overall 12.15% of Malaysian were obese (BMI: ≥30 kg/m^2) and another 26.71% were overweight

(BMI: 259 kg/m^2 - 29.9 kg/m^2). Only 49.27% of Malaysian adult had normal weight (BMI: 18.5 kg/m^2 - 24.9 kg/m^2). These findings suggest that Malaysia is facing an increasing problem of overweight and obesity among adult.

1.4 Objectives

1. To identify the nutritional and health status of Dusun in Ranau and Kuala Penyu.
2. To identify the dietary patterns of Dusun in Ranau and Kuala Penyu.
3. To measure indicators of chronic non-communicable diseases influenced by dietary intakes and lifestyles.

CHAPTER 2

LITERATURE REVIEW

2.1 Nutritional and Health Status

Nutritional epidemiology is defined as the study of the nutritional determinants of disease in human population (Spark, 2007). Malaysia is currently a developing country where by it is at the transitional state of becoming a developed nation. Hence some of the citizens of the country still suffer from various nutritional problems. Subsequently, there will be occurrence and increase prevalence of non-communicable diseases. It is an essential tool for research into possible relationships between diet and disease, especially the multiaetiological chronic diseases of developed nations, which typically have long latency periods (Willett, 1990). In order to study nutritional epidemiology, the nutritional status of the study target has to be determined.

Nutritional status is a state of health as it is influenced by the intake and utilization of nutrients (National Research Counsel, 1993). It is measured in the population as well as in individuals. At the population level, it is used to make public health recommendations. At the individual level, it is used to identify nutritional need and to plan diets to meet this need. The nutritional status of a particular person can be influenced by many factors. Ethnicity and socioeconomic status were found to be related to nutritional status (Goodman, 1999). Nutritional assessment is the process of determining the nutritional status of individuals or groups. A planning of personal health-care or community programmes will be done after the nutritional needs is identifying by a nutritional assessment (Grosvenor and Smolin, 2002).

Health status will affect the dietary habits and eating pattern of an individual. The frequency of meal consumed will not affect the health status of an

individual. However, health is dependent on what is consumed hence it is important that the daily decision made from health aspect is such that it is not affected by pseudoscience (Suriah *et al.*, 2003). There was a significant study that showed that consumers were more concern of the nutritional and fat content of food as compared to the taste of food (Tuorila and Cardello, 2002).

Defining or assessing optimal health is difficult, and consequently efforts to detect poor nutritional status have traditionally centred on nutritional deficiencies in populations. However, poor nutritional status is not confined to undernutrition. It may also caused from excessive intake or inadequate expenditure of food energy, or from excessive intake of specific nutrients, resulting in acute toxicity or chronic disease In theory, nutritional status should be attained in moderation, but not excessive in the source of energy, essential nutrients, and other food components (such as dietary fibre) not containing toxins or contaminants (National Research Counsel, 1993).

2.2 Nutritional Assessment

The evaluation of the nutritional status of the subjects was done by doing a nutritional assessment. Techniques of nutritional assessment utilize a combination of methods. It involved obtaining and interpreting the anthropometrics measurements, biochemical assessment, dietary assessment and clinical assessment. The data and information was used to determine the nutritional and health status of individuals or population groups as influenced by intake and utilization of nutrients (Whitney *et al.*, 2007).

2.2.1 Anthropometric Measurement (BMI)

Body Mass Index (BMI) is an indicator of normal weight, overweight, obese or underweight that is derived from height and weight measures. The BMI is calculated by dividing weight in kilograms by height in meter squared (kg/m^2) (Kandiah *et al.*, 2007). It is a very simple and inexpensive method for classifying people as underweight, overweight or obese. It is not as good as an indicator of fatness compare to other complicated methods of analyzing body composition, but BMI may be just as good as percent fat in predicting health risks associated with

excess weight and fat, including diabetes, hypertension, and coronary artery disease (Summerfield, 2001).

A low BMI is associated with an increase risk death compare with normal individuals (Sauvaget *et al.*, 2008). However, a low body weight has been associated with decreased vitality, increased tiredness, irregular periods, anaemia and poorer mental health (Brown *et al.*, 2000). In addition, a BMI of less than 18.5 is one diagnostic criterion for significant underweight in people with anorexia nervosa (Summerfield, 2001). Table 2.1 which was adopted from World Health Organization (1998) provides the BMIs that classify adults as underweight, overweight and 3 level of obese. The BMI associated with the greatest protection against cardiovascular disease is 22 kg/m^2 for men and 21 kg/m^2 for women (Summerfield, 2001).

Table 2.1: BMI classification for adults.

Classification	BMI (kg/m^2)	Risk of co-morbidities
Underweight	<18.5	Low (but increase risk of other clinical problems)
Normal range	18.5-24.9	Averaged
Overweight	25.0-29.9	Increased
Obese I	30.00-34.9	Moderate
Obese II	35.0-39.9	Severe
Obese III	≥40.0	Very severe

Source: WHO (1998)

2.2.2 Biochemical Assessment

Biochemical tests are a valuable adjunct in providing the most objective and quantitative data on nutritional status (Kandiah *et al.*, 2007). The identification of any nutritional problems and screening for the presence of disease is enabled when used in conjunction with dietary, clinical and anthropometric methods (Cauthorne-Burnette, 2006). It is also aids in diagnosing disease and determining disease severity in individuals. Laboratory test may identify nutritional deficiencies and metabolic abnormalities in anorexia or extreme weight loss. In obesity,

laboratory tests may identify abnormalities in glucose and blood lipids (Pitsavos, 2008) that suggest an increase risk for diabetes and cardiovascular disease.

There are several tests that are important in the diagnosis of diabetes in measuring blood glucose. The most common blood glucose level test used to diagnose diabetes is the fasting plasma glucose which requires an 8-hour overnight fast and one blood draw (Summerfield, 2001). Fasting plasma glucose between 6.1 mmol/L and 6.9 mmol/L is considered as impaired fasting glucose. A value at or above 7.0 mmol/L indicates diabetes (MOH, 2009).

Methods of dietary assessment have been remaining the most common measure of exposure to dietary fat and cholesterol in epidemiological studies. However, these methods have a number of limitations that affect both the accuracy and precision of the measurement. Given these limitations, there has been considerable interest in using tissue and blood fatty acid composition as biological markers of fat intake to improve on dietary assessment and there have been a number of good reviews on this subject (Baylin and Compos, 2006; Hodson *et al.*, 2008; Jacobs *et al.*, 1982). Validation of dietary records or recalls used on energy will not reflect the possible error in the assessment of other nutrients. The biomarkers are likely to reflect recent or usual intake.

2.2.3 Dietary Assessment

Assessment of dietary intake involved the collection of information on foods and beverages consumed. Dietary data were collected for many different purposes. They may be used to estimate population prevalence of particular foods or food components, to study time trends in consumption patterns, to compare intakes of groups, and to study the relationships between intake and health outcomes (Simko *et al.*, 1995). The consumption data can be used to compute intake of energy, nutrients, and other food components as well as the consumption patterns for specified food groups.

Dietary assessment can be collected by different approaches from an individual some of which are retrospective and prospective technique.

Retrospective approaches collect information on past diet and include dietary histories, food frequency questionnaires and 24-hour dietary recalls. Prospective approaches collect information on present intake and include the estimated food diaries, weighed food diaries and precise weighing method. The method selected depends upon the proposed use of the data, the population to be studied, size of the required sample and the resources, skills and time available to the researcher (Anderson, 1995; Simko *et al.,* 1995).

Obtaining a precise account of a person's usual food intake is challenging, as results may vary depending on both the individual's memory and honesty and the assessors' skill and training. In addition, each method has its own strengths and weakness, so best results are obtained from using a combination of methods (Whitney *et al.,* 2007). The combination of dietary assessment methods may improve accuracy and facilitate interpretation of the dietary data. Briefel (1994) reviewed the past surveys of the US Department of Agriculture which combined 24-hour dietary recalls with food frequency questionnaires (FFQ) focused on selected nutrients supported this claim. FFQ may be used as a cross-check for other dietary assessment methods such as 24-hour dietary recall and diet history (Briefel, 1994).

When reporting about foods previously consumed, untrained individuals have difficulty estimating portion sizes of foods (Cypel *et al.*, 1997; Hebert *et al.,* 1999; Thompson *et al.,* 1987). Smith *et al.* (1991) found that respondents appear to be relatively insensitive to changes made in portion size amounts shown in reference categories asked on FFQs. For these limitations, three-dimensional measurement aids (household measure, real food samples, food replicas and food models) and two-dimensional measurement aids (food photographs, computer graphics, food package labels and drawing of real foods) were used to help the respondents visualize and describe the amounts consumed (Cypel *et al.*, 1997). The accuracy of reporting using either models or household measures can be improved with training (Weber *et al.,* 1997).

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