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ASSOCIATION BETWEEN BODY ADIPOSITY, TEST AQUITY FOR SALT AND FOOD PREFERENCE WITH HYPERTENSION : A STUDY ON NATIONAL SAVING BANK CLERKS

BY

WILAILUCK TANTIWATTANA

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN PUBLIC HEALTH
(NUTRITION)

บัณฑิตวิทยาลัย มหิดล

กิตติกรรมประกาศ

IN THE

FACULTY OF GRADUATE STUDIES

OF

MAHIDOL UNIVERSITY

1986

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ชื่อวิทยานิพนธ์ ความสัมพันธ์ระหว่างระดับของความอ้วน การรับรู้รสเค็ม และการเลือกอาหารบริโภค กับโรคความดันโลหิตสูง : การศึกษาในกลุ่มพนักงานธนาคารออมสิน ในกรุงเทพมหานคร

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บทคัดย่อ

วิทยานิพนธ์นี้บ่งวิจัยถึงปัจจัยที่อาจเป็นสาเหตุของโรคความดันโลหิตสูง ได้แก่ ระดับความอ้วน (ดัชนีมวลของร่างกายและปริมาณไขมันของร่างกาย), ระดับการรับรู้รสเค็ม (การแยกรสและการรับรู้รสเค็ม) และการเลือกอาหารบริโภคบางประเภท ได้ศึกษาในพนักงานธนาคารออกสิน ของสำนักงานใหญ่ กรุงเทพมหานคร จำนวน 73 คน ที่ได้รับการตรวจพบว่าเป็นโรคความดันโลหิตสูง โดยได้เปรียบเทียบกับกลุ่มตัวอย่างที่เลือกจากพนักงานในหน่วยงานเดียวกัน จำนวนเท่ากัน และมีอายุ, เพศ เหมือนกัน

ผลการวิเคราะห์ทางสถิติพบว่า โรคความดันโลหิตสูงมีความสัมพันธ์กับปัจจัยหลายอย่างด้วยกัน คือ

1. ประวัติการเป็นโรคความดันโลหิตสูงในครอบครัว (X^2= 7.806, P = 0.0054)
2. การมีโรคประจำตัว คือ โรคหัวใจ และโรคไต (X^2 = 5.561, P = 0.0116)
3. การออกกำลังกาย (X^2= 4.351, P = 0.028)

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4. การรับรู้รสพบว่า ในกลุ่มความดันโลหิตสูง มีการรับรู้รส (Detection threshold) สูงกว่ากลุ่มเปรียบเทียบ (กลุ่มความดันโลหิตสูงใช้ความเข้มข้นของน้ำเกลือในการรับรู้รสสูงกว่าในกลุ่มเปรียบเทียบ) $x^2 = 5.43514$, $P = 0.0197$

5. การรับรู้รสเค็มพบว่า ในกลุ่มความดันโลหิตสูง มีการรับรู้รสเค็ม (Recognition threshold) สูงกว่ากลุ่มเปรียบเทียบ $x^2 = 5.64084$, $P = 0.0175$

6. การเลือกบริโภคอาหารบางประเภท มี

6.1 การดื่มสุราเป็นประจำทุกวัน ($t = 1.6588$, $P = 0.05$)

6.2 การบริโภคกะทิในปริมาณมาก ($t = 1.703$, $P = 0.0453$)

6.3 การบริโภคไขมันจากเนื้อหมู ($t = 2.6662$, $P = 0.0044$)

แต่การเลือกบริโภคอาหารประเภทผัก และการเติมน้ำปลาลงในอาหารพบว่าไม่แตกต่างกัน เมื่อเปรียบเทียบกับกลุ่มความดันโลหิตปกติ

กลุ่มความดันโลหิตสูงมีดัชนีมวลของร่างกาย (Body Mass Index) สูงกว่ากลุ่มเปรียบเทียบ ($P < 0.0001$ ในเพศหญิง, $P = 0.043$ ในเพศชาย) เช่นเดียวกับปริมาณไขมันในร่างกาย (% Body Fat) $P = 0.0005$ ในเพศหญิง, $P = 0.025$ ในเพศชาย

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Thesis Title : Association Between Body Adiposity, Test Aquity for Salt and Food Preference with Hypertension : A Study on National Saving Bank Clerks.

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ABSTRACT

The thesis is attempted to identify cousative factors to hypertension : Body adiposity (expressed as Body Mass Index and Percentage of Body Fat), Test Aquity for Salt (expressed as Detection threshold and Recognition threshold) and Food preferences (specified on alcoholic consumption, salt addition to food, high fatty meat intake and low fibre intake). The study was undertaken from 73 known hypertensive personels of the National Saving Bank of Thailand, Bangkok office, using sex and age matched normotensive personels from the same office as controls.

The result showed that hypertension has high statistical association with :

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1. History of hypertension in family (x^2 = 7.806, P = 0.0054).
2. Any disease known; specified on Heart and Kidney diseases (x^2 = 5.561, P = 0.0116).
3. Exercise practice (x^2 = 4.351, P = 0.028).
4. Detection threshold for salt (x^2 = 5.43514, P = 0.0197).
5. Recognition threshold for Salt (x^2 = 5.64084, P = 0.0175).
6. Certain food preference patterns : which are
   - 6.1 Heavy drinkers (t = 1.6588, P = 0.05).
   - 6.2 High coconut milk consumption (t = 1.703, P = 0.0453).
   - 6.3 High fatty pork meat consumption (t = 2.6662, P = 0.0044).

Whereas, there was no association exist for salt consumption and low fibre intake, when using both statistic Chi square test and Student's t-test.

Hypertensives have higher Body Mass Index (BMI) than Normotensives (P 0.0001 for females, P = 0.043 for males) the same as for Percentage of Body Fat (% BF) (P = 0.0005 for females, P = 0.025 for males).

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CHAPTER I.

INTRODUCTION

The danger of hypertension is notorious not only for deteriorating to health but also for affecting to the economic and social well-being of the country. This disease know to be the leading cause of death and disability among adults in devloped as well as developing countries. Moreover it remains the major risk factors for coronary as well as cerebral and renal vascular disease. Because of its severity, over half of all deaths in the United State has been reported (Roberts, W.C., 1975). It was found that among American adults as high as 25 percent of whom (as classified by WHO) having abnormal high blood pressure (Kaplan, N.M., 1983). For Thai, the anual statistical reports of the Ministry of Public Health from 1981 - 1984 demonstrated that the trend of increasing incidence of hypertension became the important cause of death. There are many risk factors contributable to hypertension (Batterman et al., 1975). Cruickshank et al., 1982 showed that age between 30 - 35 and 50 years old were on high risk of developing hypertension. Family history and race have high correlation with the disorder. Blacks known to have hypertension more frequency than do whites and showed more morbidity and mortality. From the Framingham study on the coronary heart disease the data showed that the 1- percent of body weight increase had reflected the rise of 6.5 mmHg of systolic blood pressure (Kannel, W.B. et al., 1979). Kenneth,

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M. et al., 1983 studied the effect of alcohol consumption on blood pressure in Health Screening Clinic of Sydney Hospital, and found that blood pressure would be significantly raised when one consumed alcohol to the extent of 500 gm/wk. They also suggested that restriction of salt would be a good method for the control of hypertension. Michael and Bonnie, 1980 reported that the American were of high risk to hypertension because of high sodium food consumption. Somjit, 1983 studied in soldier in North Africa during World War II and the people in the city during this revolution has found that long period of stress has caused hypertension. Race, heredity, as well as other environmental risk factors, such as food pattern, obesity and mental stress may be contributable. If people could avoid those factors, the incidence of hypertension may decreased.

The relationship between hypertension and body adiposity (ie body mass index and % body fat), aquity for salt and food consumption pattern has been reported from many countries, but have never been done in Thais. If they had shown to be the causes of this disorder, the study on them is thus necessary, as Hypertension is becoming a Public Health problem for this country.

OBJECTIVES OF THIS STUDY

This study intends to prove the relationship between factors which may be contributable to the cause of hypertension, they are :-

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1. The body adiposity, expressed as Body Mass Index (BMI) and percentage of Body Fat (% BF).

2. The test aquity for salt, expressed as Detection and Recognition threshold.

3. The food preference, expressed in term of some food items :- Alcoholic consumption, salt addition to food, high fatty meat and low fibre consumption.

If they are avoidance of them may be implemented for the prevention as well as for the control of the disorder.

HYPOTHESIS

1. The hypertensives have high body mass index than the normotensives.

2. The hypertensives have high percentage of body fat than the normotensives.

3. The hypertensives have high detection threshold for salt than the normotensives.

4. The hypertensives have high recognition threshold for salt than the normotensives.

5. The hypertensives have food preference in term of alcoholic consumption, addition of salt to food, fatty meat consumption and fibre intake different from the normotensives.

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SCOPE OF THE STUDY

The study was undertaken on 73 Hypertensive personnels employed by the National Saving Bank of Thailand all of whom has been refered by the Bank Infirmary. The 73 Nowmotensive controls were selected from the same office with age and sex match. Anthropometric measurements (weight, height, 3 sites of subcutaneous skin fold measurements in females, abdominal circumferences in males), detection and recognition threshold for salt and food preference interview were recorded.

LIMITATIONS OF THIS STUDY.

1. The subjects were hypertensive individuals of National Saving Bank, who have already under the medical supervision. So it can not represent all of the hypertensives.

2. Anthropometric and food behavior patterns may be modified due to the previous medical supervision.

3. Because of limited number of subjects this study is of purposive type thus can not be performed by random sampling.

ASSUMPTIONS OF THIS STUDY.

1. Those factors which have been proved to be highly associated to hypertensive patients can be termed as risk factors statistically.

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2. It is the urban population therefore they can be represented for Thai urban hypertensives.

3. Hypertensives and Normotensives were matched by sex, age and socioeconomic would give a high statistic accuracy.

4. As all anthropometric measurements were conducted by the same investigator thus the precision of measurements would be expectedly high.

VARIABLES.

I. Independent variables :-

1. body mass index (BMI).
2. percentage of body fat (% BF).
3. detection threshold for salt.
4. recognition threshold for salt.
5. food preference.

II. Dependent variable is hypertension.

DEFINITIONS OF TERMS

1. Hypertension according to World Health Organization classification : systolic blood pressure up to or higher than 160 mmHg and/or diastolic blood pressure up to or higher than 95 mmHg for person over 40 years old.

2. Body Mass Index (BMI) is the ratio of Weight (kg) to Height^2(m^2). This index was proved to be highly correlated with weight

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but independently with height, thus it is relatively correlated with amount of fat or adiposity (Billewicz, W.Z. et al., 1962).

3. Percentage of Body Fat (% BF), defined as the percentage of total body fat to the body weight. The estimations of body fat were calculated from separate equations according to males and females as shown in Appendix 1.

4. Test aquity for salt were considered as :-

4.1 Detection threshold for salt defined as the lowest concentration of sodium chloride solution, at the level of which the subject could consistently distinguish from water.

4.2 Recognition threshold for salt defined as the lowest concentration of sodium chloride solution at the level of which the subject could consistently recognize correctly as salty test.

5. Food preference defined as selective food groups which are consummed more frequent are the prefered food groups.

BENEFITS AS EXPECTED FROM THIS STUDY.

This study intends :-

1. To investigate for those environmental factors that may cause hypertensions.

2. To inform those causative factors to hypertensives to control the disorder and avoid the complications that may incurred from the uncontrol condition.

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3. To give education to healthy population to avoid such factors for the prevention of the disorder.

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Chapter II

REVIEW LITERATURES

At the present time the hypertension is regarded as an important cause of death and disability among the elderly people in spite of the development of medical science that the disorder can be controlled. The complications such as coronary heart disease, cerebral vascular disease and renal insufficiency are still high. There is no technique to identify those middle age persons who are susceptible to developing hypertension whereas those who are at great risk for developing subsequent hypertension can be expected. Those risks are as followed.

1. History of hypertension in family

Biron, P. et al in 1967 demonstrated that natural children from hypertensive families have their blood pressure closely correlated with their parents than their adopted ones. This showed the role of heredity than the environments.

Ernest Harbury et al in 1970 studied among Nigroes in Detroit, 1966-1970. Fifty-six "family sets" or 280 persons were interviewed and blood pressure recording were taken by trained nurses. Each family set was composed of an index, a spouse, a sibling and a first cousin of index and an unrelated person in the

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census tract match to index. They found that genetic was related with blood pressure.

William et al in 1970, studied the construction of a genetic variable to analyze the heritable component in blood pressure variability using a family set composed of an index and spouse, a sibling and a first cousin of index, and an unrelated person in the tract match to index. They found that genetic distancescale when measured against variables such as height and skin color was correlated with blood pressure.

Borhani et al in 1969, found, in Alameda County, no significant spouse aggregation for systolie blood pressure but only for diastolic blood pressure among all spouses, but not by duration of marriage.

Joseph et al in 1979, analysed the familial aggregation of blood pressure to estimate of the role of gene and household environment and family members. They found that shared environment explains larger fractions of the parent-natural child and the full sib correlations for diastolic blood pressure than for systolic blood pressure.

Moll et al in 1983, they concluded from the Detroit Project utilizing an innovative "family sets" approach indicated that unspecified environmental factors rather than genes are the main determinants of blood pressure variation in blacks and whites. The family sets estimates of heritability were significant for systolic and diastolic blood pressure in both blacks and whites.

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Joseph et al in 1984, studied in 392 healthy, fullterm, appropriate-weight infants were measured blood pressure at birth, 6, 15, 24, 36, 48 and 60 months of age. They found that systolic blood pressure rose from birth to six months of age, remained at a plateau until 15 months of age, and from 24 to 60 months rose an average of 1 mmHg per year. Diaslolic blood pressure rose from birth to 24 months but showed little change from 24 to 60 months.

Blood pressure did not vary between sex, or socio-economic status during the first five years of life. The child's blood pressure was not association with parent's pressure but closer of heart rate. The child's heart rate was inversely association with the parent blood pressure. During the first five years of life, a low hart rate may be a more significant risk factor to adult hypertension than elevate blood pressure.

2. Age, sex and racial factors.

In Hypertensive detection and follow up program Co-operative Group in Framingham demonstrated that blood pressure rise stepwise with age in both sexes, and also hypertensive prevalent is increase with age. Data from Health and Nutrition Examination Survey in 1971-1974, showed the prevalence of hypertension increased with age in both sexes among both Whites and Blacks, the prevalence was as high as to 60 percent in female Blacks (Fig I). It was

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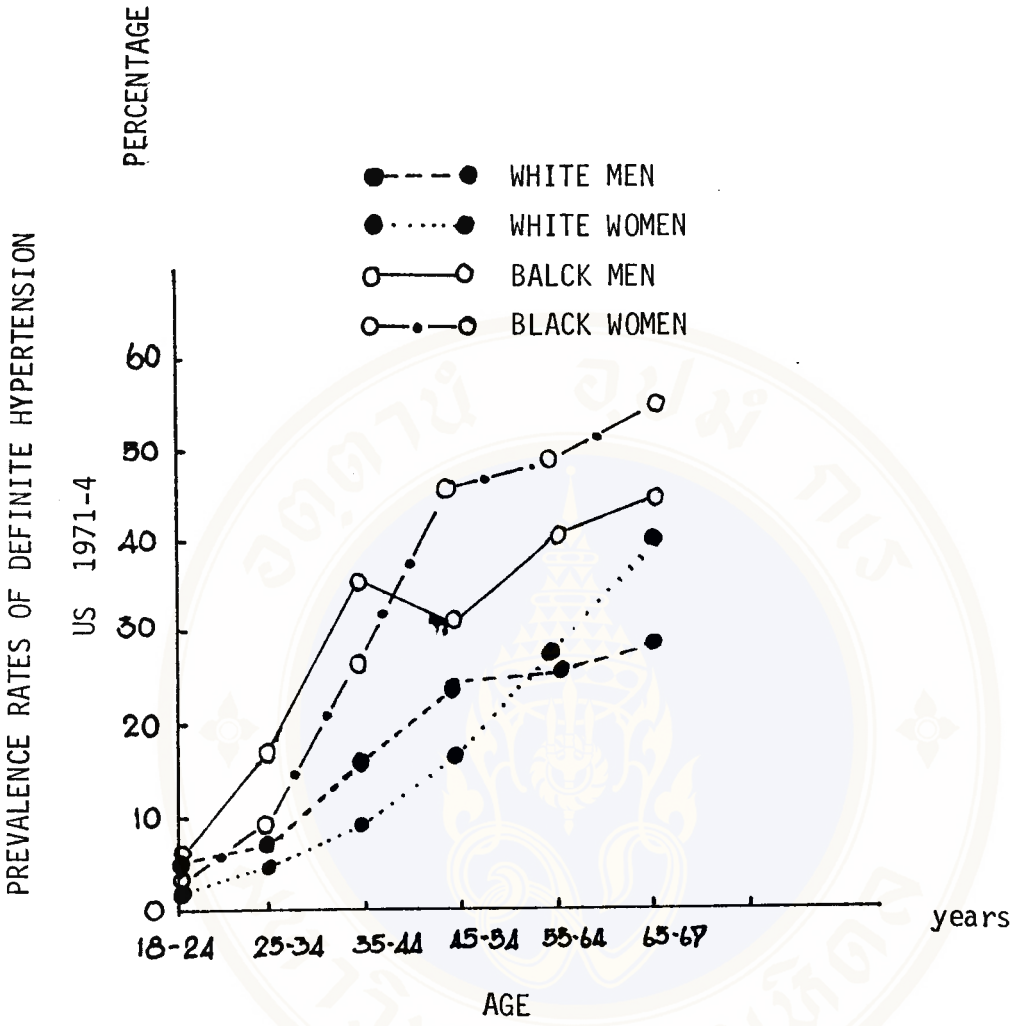

Figure I Prevalence of hypertension in the United States defined as the percentage of people with systolic blood pressure of at least 160 mmHg or diastolic blood pressure of at least 95 mmHg. (Data from the Health and Nutrition Examination Survey, 1971-1974 Source: Advance Data, Vital and Health Statistics of the National Center for Health Statistics, No. 1 October 18, 1976).

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interesting to note that females of both Whites and Blacks whose prevalence rate of hypertension passed over male after 40 and 55 years old for Blacks and whites respectively. Blacks are reported to have morbidity and mortality than whites (Cruickshank, J. D. et al, 1982).

Sever et al in 1980 mentioned that Blacks may be sensitive to "sodium loads" when they migrate to urban and had excessive high sodium intake. This may due to disruption of their physiological machanism of salt conservation, when they originally lived in hot crimates with low salt intake. The report of Xhosa people of South Africa whose blood pressure rise when they migrated to urban areas supported this view (Messerli, F.H. et al, 1979). From U.S. National Health Survey in 1981, revealed that the prevalence of hypertension among Whites and Blacks when using the cut-off point of $\geq$ 160/95 mmHg. according to WHO and after age adjustment was 16 and 33 percents respectively.

William et al in 1984, studies relationships of blood pressure to age, sex, and race. They found systolic and diastolic blood pressure were progressively increase in advancing older ages for US males and females through age 55 years (Fig. II). Although systolic pressure was higher after this age, the relationship for diastolic-pressure changed. For all males and for black females, the mean diastolic pressure plateaued and, for white males, was lower in the group

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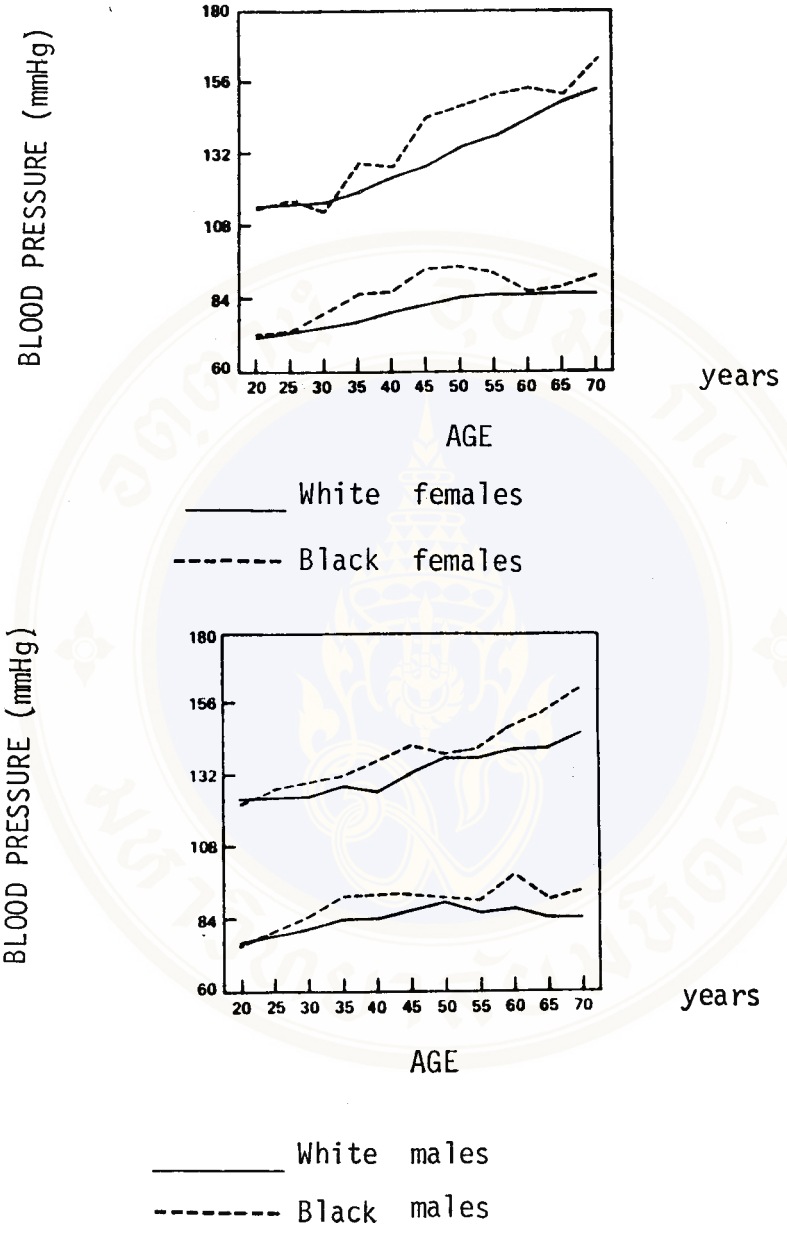

Figure II Blood pressure by age for white and black males and females in the United States, 1971-1975. (Data from the first National Health and Nutrition Examination Survey-1, 1971-1975 Source: William et al : Blood pressure and nutrition examination survey. Vol 120. No. 1: 17-28, 1984).

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65-74 year of age. For white females, diastolic pressure was higher in the older groups, but the slope was less. There is more variation in the curves for black males and females because of the smaller numbers in each group and relatively greater variability. The age-related trends are similar for black and whites, although mean blood pressures (both systolic and diastolic) are significantly higher for blacks than for whites.

3. Obesity reported to be strongly correlated to hypertension.

Larimore, J. W. in 1923 showed the relationship between blood pressure and body build in 417 factory workers in USA, the stocky type had the highest while the asthenics had the lowest. Reports from Mayo Clinics in 1929, showed that systolic blood pressure increased with the increase of weight in both sexes, but the diastolic only increased with weight in females. This study was undertake on 2,042 healthy subjects (962 males, 1,080 females). Robinson, S. C. et al in 1939 showed that obese females and males have 6, and $1\frac{1}{2}$ times of hypertension than non-obese respectively. Benjamin et al in 1969 found high relationship between blood pressure in extreme obese of younger than 60 years of age who had positive history of hypertension in family. Systolic blood pressure has greater association with body weight than diastolic. Lieberman et al in 1978, could bring blood pressure of severe hypertensives to normal by weight reduction alone, without salt restriction. This

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study could lower the means of systolic and diastolic blood pressure to extent of 25 and 20 mmHg respectively. Padmavida, S. et al in 1959 studied the relationship of blood pressure and body weight in 1132 low economic adults and 224 high economics, found that blood pressure increase with weight and age in high economics but not in low. From U.S. Nutrition Survey in Armed Forces in 1960 revealed that both systolic and diastolic blood pressure increased with each increment of relative weight. This confirmed by 4,900,000 policy holders of U.S. Metropolitan Life Insurance that blood pressure rose with weight increase (Aleksandrow, D. 1967) and more hypertension found in obese group. Data from Framingham's study on cardiovascular epidimeology showed of 6.5 mmHg rise of blood pressure in every 10 percent of weight increased. (Kannel, W. B. and Gorelon, T. 1979). The physiological mechanism of relationship of weight and hypertension is unknown, but Siervogel eraborated that it appeared to be related to body fat mass than wight alone (Siervogel, R. M. et al, 1982).

4. Nutrients intake

At present nutrition increases roles in medical and public health areas. Many investigations had identified factors that caused the diseases and looked for methods for prevention. Those diseases are diabetes mellitus, heart disease, renal disease and hypertension. Particularly hypertension is closely related to

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fat, protein, minerals and dietary fibre. There are a lot of reported which studied about the relationship between food and hypertension.

Wright, A. et al, 1979 suggested that the intake of dietary fibre combined with unsaturated fatty acid consumption can lower the blood pressure.

Dodson, P. M. et al, 1984 claimed that grop in controlling of food intake in hypertensive by taking food that consisted of more fibre, low fat and sodium can lower blood pressure and suggested to be the first step in treatment for this disease instead of taking medicine.

Rouse, I.L. and Beilin, L.J., 1984, studied about vegetarian diet, blood pressure and cardiovascular risk in 331 volunteers aged between 25 and 44 years. They found that the mean of systolic and diastolic blood pressure and serum cholesterol fell significantly during feeding with a vegetarian diet.

The blood pressure lowering effect of elevating the dietary polyunsaturated/saturated (P/S) ratio has been assessed in a randomised by Margetts et al in 1984. Subject were allocated

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either to a controll group who ate a low P/S ratio diet throughout and a experimental group who ate a high P/S ratio diet. They found there was no significant relationship between change in estimated dietary P/S ratio and change in systolic and diastolic blood pressure.

Dodson et al in 1985, studied long-term follow-up of the treatment of essential hypertension with a high-fibre, low fat and low-sodium dietary regimen in 31 hypertensive patients. The results are reported of 19 patients who attended after 3 months and for a long-term mean follow-up period of 3-9 years. A significant reduction in systolic ($P < 0.01$) and diastolic blood pressure ($P < 0.001$) was do served at 3 months and again after 3.9 years ($P < 0.05$ and < 0.001 respectively).

Sylvia et al in 1985, studied effective dietary intervention in hypertensives: sodium restriction and weight reduction. They found the groups were generally comparable regarding variables potentially affecting success in salt restriction or weight reduction. However, there was a lower proportion of blacks in the nonoverweight sodium restriction group (55.9%) than in its comparison control group of those not no medication (72.9%, $P < 0.05$)

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Salt intake and Hypertension

The highest incidence of hypertension is found in northern Japan where the sodium intake were 400 mEq (100 mEq sodium = 5.8 gm sodium chloride). While some 20 primitive societies who has low sodium intake (10 to 60 mEq/day) were reported to have virtually no hypertension. However, other primitive population who have sodium intakes similar to those in industrialized populations such as the American (100 to 200 mEq/day) were reported to have the same prevalence of hypertension similar to that in the United State. It showed that salt itself even in different life styles and eating habits, is pesponsible for the provalence of hypertension in "high sodium" societies. Hypertension tends to cluster in families. In a high sodium intake group where sodium intakes are 125 to 250 mEq/day the study elaborated that there are individuals who are salt sensitive; since those who do and others who do not develop hypertension have roughly similar sodium intakes (Louis Tobian, Jr, 1979).

Mac Greger et al., 1982, concluded that limitation of sodium salt benefit in treatment for hypertension and should be combined with lowering of the body weight.

Pangborn and Pecore, 1982 suggested that dietary sodium intake and taste sensitivity of sodium chloride are correlated. They used several psychophysical procedures to measure the relationship between the intake of dietary sodium of a normotensive student

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population and taste perception of sodium chloride. The result of the study failed to demonstrate a strong relationship between salt intake and gustatory behavior.

Bertino et al, 1982 studied the long-term reduction in dietary sodium had altered the taste of salt. The results demonstrated that the preferred level of salt in food depends on the level of salt consumption and that this level could be lowered after a reduction of sodium intake.

Langford, G. H., 1981, found that sodium excretion and systolic blood pressure are correlated. Modest sodium restriction will enable than to obtain good blood pressure controlled.

Salt test threshold and hypertension

It is widely claimed that excessive salt intake may be the cause of hypertension, expecially in heriditary susceptible individuals. Many investigators tried to elucidate the fact that Hypertensives consume more salt because they can not taste salt as well as Normotensives, as the result of their sensitively for salt test are low, or in the other words-their taste thresholds are elevated.

One of the first experiments was conducted by Fillis et al in 1962 by the method of "sip and spit". Subjected were presented several sets of 4 cups, 3 of which contained water, one contained different

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concentrations of salt. Started the experiment with the set of lowest concentration. The "Detection Threshold for Salt (DTS)" and the "Recognition Threshold for Salt (RTS)" were the lowest concentration at which subject could detect the difference from water correctly and could recognise salty test correctly respectively.

This study showed that Hypertensives had elevated RTS or diminish ability to recognize the salt test as compared with controls, so that they tend to consume more salt.

Wotmon et al in 1976, used a modified technique from Fallis, by using several sets of 8 cups, 4 of which contained water, the other 4 contained the same concentration of salt. Several sets of different salt concentrations were presented to subjects to separate the cups containing the salts from those containing water correctly. This study confirmed Fallis, that Hypertensives had elevated RTS.

Schechter et al in 1974, studied the salt preference in Hypertensives, following the method which Richter experimented on adrenalectomized rats. Hypertensives were found to have elevated RTS (at 45 mM VS 30 mM) but not for the DTS as compared with controls. Then the subjects were asked to drink water or salt solution (at 15 mM) or to mix different amounts of each as they desired. They found that Hypertensives consumed more salt and greater total fluid intake than controls.

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Lauer et al in 1976, studied on school children with wide range of blood pressure, by using the rate of pleasantness or unpleasantness expressed as 9 point hedonistic scale, series of beef broths and tomato juices with various salt concentrations were presented to each subject. The test solutions were analysed for sodium contents. Salt preference resfered as salt concentration of those prefered broth or tomato juice. This study showed that blood pressure was not associated with both DTS and salt preference.

Henkin et al in 1971-1974 conducted studies on DTS and RTS on various conditions as well as normals. His technique was to place alternatively one drop of different salt concentrations and 2 drops of water on the 2 sides of tongue. They found that DTS and RTS were the same in Hypertensives and Normotensives.

Thus, the studies of salt threshold in hypertension produced different results. One of the reasons may be the unifamily of the method. Area on tongue where the drop of test solution applied, the duration of the stimuli the adapting conditions of the tongue, all these should be in consideration for the validity of the conclusion.

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CHAPTER III.

METHODOLOGY

STUDY DESIGN

This is a retrospective, purposive design of study, to identify those causative risk factors for hypertension.

Subjects

73 hypertensive subjects were individuals who came for medical care at the Infirmary of National Saving Bank. An equal number of control normotensives were selected to match in sex, age and socio-economic with the affected group.

MATERIAL

1. Sphygmonanometer and stetoscope.
2. Beam balance scale.
3. The Harpenden skinfold caliper.
4. A plastic measuring tape.
5. A questionnair consists of general informations and food frequency for alcoholic consumptions, salt addition to food, high fatty meat and fibre content foods.

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6. Seven test solutions of 6, 12, 18, 30, 60, 150 and 300 m moles/litre of sodium chloride concentrations were used for measuring salt detection threshold and salt recognition threshold.

METHOD

1. Anthropometric measurements.

1.1 Height was measured using beam balance scale, recorded to the nearest 0.5 cm. Subject standed with heels, buttocks and back pressed firmly to a measuring bar. The head was then adjusted so as the cranial vertex touching the measuring bar, then the height was recorded.

1.2 Weight was measured to the nearest 100 gm on the beam balance scale, the subjects were on light clothings.

2. Body adiposity.

2.1 Percentage of Body Fat (% BF).

All females were measured for the skinfold thickness with Harpenden caliper, having pressure of 10 gm/cm^2. Skinfold thickness was picked up between the thumb and the index finger of the investigator with the left hand and lifed up by taking care that no underlying muscle tissue was included. The reading was made three times record the average value. There were three sites of skinfold thickness, abdominal skinfold, tricep skinfold and sub scapular skinfold.

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a. Tricep skinfold thickness. The subjects stood erect with Right arm relaxed and hang downward along the side of body. The caliper was applied adjacent to the fingers grasping a fold of skin and subcutaneous tissue over the tricep at mid-arm point reading to nearest 0.1 mm.

b. Subscapular skinfold thickness. In the standing position a fold of skin and subcutaneous tissue over the inferior angle of the right scapular was grasped so as to paralled a line about 45 degree from the horizontal level going medially upward. The caliper was applied to the skinfold adjacent to the grasping fingers reading to mearest 0.1 mm.

c. Abdominal skinfold thickness. The subjects lied with supine position breathing quietly and knee raised to relax the abdominal muscle, a fold of skin and subcutaneous tissue of the abdomen 2 inch to the right of the umbilicus was measured with caliper reading to nearless 0.1 mm.

In males, the abdominal circumference at umbilical level was measured to nearest 0.5 cm with a tape closely fitted to the nude surface. All subjects were in standing position. Then the calculation of the body adiposity was performed from separate equation, according to sex as shown in Appendix 1.

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Formula for calculating percentage of body fat.

in males

$$\% \text{ Body Fat} = 70.690 (W/H^2 \%) + 0.291 (\text{Abd.Cir}) - 26.508$$

(Rajatasilpin, A. et al., 1979)

where

W = The body weight (kg)

H = The body height (cm)

Abd.Cir = Abdominal circumference at umbilicus level in cm.

in females

$$\% \text{ Body Fat} = 22.0717 + 0.341\ S + 0.4309\ OW$$

(Visesshakul, D. et al., 1983).

where

S = Sum of three skinfold in mm.

OW = Percent overweight definded as percentage at excess weight from standard weight.

2.2 Body Mass Index (BMI).

Body mass index were measured by using the same formula in both sexes.

$$\text{Body Mass Index} = \text{Weight (kg)}/\text{Height}^2\ (m^2)$$

(Billewicz, W.Z. et al., 1962)

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Method of Determination of Detection Threshold (DTS) and Recognition Threshold (RTS) for salt.

1. Test Solution : Sodium chloride solution (mmoles/litre). There were 7 dilutions : 6, 12, 18, 30, 60, 150 and 300 mmoles/litre. These test solutions were kept in separate 7 bottles with one medicine dropper provided for each.

2. The tests were undertaken, preferrable at mid-morning or mid-afternoon, approximately $1\frac{1}{2}$ - 2 hours after meal. For smokers, the tests were postphoned to 1 hour, after the last smoke. All Hypertensives were on various medications.

3. The tests were carried on in a quiet separate side-room attacted to the subject's office. The tests were always undertaken on the paired control following the test of the corresponding subjects.

4. Two sides of the anterior part of tongue was used as the area for salt stimulation.

According to Henkin's method : started with the lowest salt concentration, applied one drop of water on one side of tongue first, then applied one drop of the salt solution on the other side, after that another drop of water on the alternate side. Asked the subjects to tell the differance of the 3 drops. Higher salt concentrations was administered to subjects until they can tell the difference.

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To confirm for the accuracy of the test aquity, on higher salt concentration was administered to the subject in the same way, till the consistent correct answers obtained.

The "DTS" was the lowest salt concentration that subjects could tell the difference from water.

The procedure was undertaken for the "RTS" in the same way as the determination of "DTS". The lowest salt concentration at which subject could recognise the salty test was termed as "RTS". To obtain the accuracy of the test, the same up and down technique of applying from the lowest salt solution was used.

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DATA ANALYSIS (Dixon, J.W. et al., 1983; Siegel, S., 1956 and Nie, N.H., 1975).

1. Descriptive statistics were applied for the general characteristics of the subjects and controls.

2. Chi-square Tests were applied to prove the association between hypertensives with 4 variables : general environmental conditions, Detection Threshold for salt, Recognition Threshold for selts, and selected food groups.

3. Student's t-Tests were applied to test the difference of means of Body adiposity of Hypertensives and Normotensives.

The statistical method used in this study shown in Appendix (2).

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CHAPTER IV.

RESULTS

Table 1 showed the general characteristics of 73 pairs of hypertensives and normotensives whose distributions of sex, age and socioeconomic were compared. There was no difference between the groups.

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Table 1. General characteristics of 73 pairs of Hypertensives and Normotensives.

	Hypertensives		Normotensives	
	n	%	n	%
1. Sex :				
male	53	72.6	53	72.6
female	20	27.4	20	27.4
Total	73	100.0	73	100.0
2. Age (yrs) :				
30 - 40	8	11.0	7	9.6
41 - 50	36	49.3	35	47.9
51 - 60	29	39.7	31	42.5
Total	73	100.0	73	100.0
3. Marital status :				
single	7	9.6	9	12.3
married	58	79.5	60	82.2
widow or divorced	8	10.9	4	5.5
Total	73	100.0	73	100.0
4. Living locations :				
urban	36	49.3	38	52.1
rural	37	50.7	35	47.9
Total	73	100.0	73	100.0
5. Religions :				
Buddhists	71	97.3	72	98.6
Islams	2	2.7	1	1.4
Total	73	100.0	73	100.0

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Table 1. Continued.

	Hypertensives		Normotensives	
	n	%	n	%
6. Level of education :				
below 12 years in school	40	54.8	38	52.1
12 years in school	6	8.2	9	12.3
Vocation level	12	16.4	15	20.5
University level	15	20.6	11	15.1
Total	73	100.0	73	100.0
7. Total number of persons in family :				
1 - 3 persons	5	6.8	6	8.2
4 - 6 persons	43	58.9	41	56.2
> 6 persons	25	34.3	26	35.6
Total	73	100.0	73	100.0
8. Salaries : (bahts/month)				
no answer	1	1.4	-	-
1001 - 3000	-	-	-	-
3001 - 5000	4	5.5	1	1.4
5001 - 8000	22	30.1	33	45.2
8001 - 10,000	12	16.4	16	21.9
> 10,000	34	46.6	23	31.5
Total	73	100.0	73	100.0

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Table 1. Continued

	Hypertensives		Normotensives	
	n	%	n	%
9. Total family income (bahts/month)				
no answer	1	1.4	-	-
3001 - 5000	-	-	-	-
5001 - 8000	6	8.2	5	6.8
8001 - 10,000	22	30.1	20	27.4
10,001 - 20,000	18	24.7	28	38.4
> 20,000	26	35.6	20	27.4
Total	73	100.0	73	100.0

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Table 2 showed that Hypertensives have high statistic association on : History of hypertension in family (X^2 = 7.806, P = 0.0054), exercise practice (X^2 = 4.351, P = 0.028). Heart and Kidney diseases known (X^2 = 5.561, P = 0.0116). No association existed on : job satisfaction,ways and time spent in travelling to work, and frequency of medical check-up.

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Table 2. Association of variable related to the hypertensives disorder in Hypertensives and Normotensives.

	Hypertensives		Normotensives		X^2-test	df	P-value
	n	%	n	%			
1. History of hypertension in family							
none	37	50.68	50	68.49	7.806	1	0.0054*
father and/or mother	16	21.92	5	6.85			
nearly relative	20	27.40	18	24.66			
Total	73	100.00	73	100.00			
2. Job satisfaction							
not satisfy	48	65.8	57	78.1	1.6617	1	0.5611
satisfy	25	34.3	16	21.9			
Total	73	100.0	73	100.0			
3. Exercise Practice							
regular	24	32.9	34	46.6	4.351	1	0.028*
occasional	29	39.7	28	38.4			
not at all	20	27.4	11	15.2			
Total	73	100.0	73	100.0			
4. Travelling to work by							
car driving	38	52.1	38	52.1	0.0137	1	0.9477
bus or walking	35	47.9	35	47.9			
Total	73	100.0	73	100.0			

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Table 2. Continued.

	Hypertensives		Normotensives		X^2-test	df	P-value
	n	%	n	%			
5. Time (hrs) spent for travelling to work/day							
< 3	59	80.8	58	79.4	0.043	1	0.8908
> 3	14	19.2	15	20.5			
Total	73	100.0	73	100.0			
6. Physical check up							
Once longer than a year	3	4.1	8	11.0	1.573	1	0.5819
1 - 2 times/year	70	95.9	65	89.0			
Total	73	100.0	73	100.0			
7. Heart and kidney disease known							
not known	57	78.1	68	93.2	5.561	1	0.0116*
known	16	21.9	5	6.8			
Total	73	100.0	73	100.0			

Statistic significant, $P < 0.05$

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The body mass index of subjects were estimated high statistic difference from Normotensives were found (Table 3). Both male and female Hypertensives have higher BMI than Normotensives with statistic significance (24.468 vs 23.602, $P = 0.043$ for males, 27.796 vs 23.892, $P < 0.0001$ for females).

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Table 3. Comparison of Body Mass Index (BMI) between Hypertensives and Normotensives according to sex.

Sex		n	Body Mass Index** $\bar{x}$	S.D.	t-test	df	P-value
Male	Hypertensives	53	24.468	3.404	1.728	104	0.043*
	Normotensives	53	23.602	2.599			
	Total	73					
Female	Hypertensives	20	27.793	3.618	6.712	38	<0.0001*
	Normotensives	20	23.892	3.406			
	Total	73					

* Statistic significant, $P < 0.05$

** Body Mass Index = Weight (kg)/Height^2 (m^2)
(Billewicz, W.Z. et al., 1962).

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Table 4 showed both male and female Hypertensives have more % BF than Normotensives with statistic significance (15.864 vs 14.458, P = 0.025 for males, 41.4116 vs 33.3089, P = 0.0005 for females).

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Table 4. Comparison of percentage of Body Fat (% BF) between Hypertensives and Normotensives, according to sex.

		n	% Body Fat** $\bar{x}$	S.D.	t-test	df	P-value
Males	Hypertensives	53	15.8639	4.7713	2.004	104	0.025*
	Normotensives	53	14.4575	3.6306			
	Total	73					
Females	Hypertensives	20	41.4116	9.1042	6.0418	38	0.0005*
	Normotensives	20	33.3089	8.2436			
	Total	73					

* Statistic significant, $P < 0.05$

** % Body Fat for male = 70.690 (W/H^2%) + 0.291 (Abd.Cir) - 26.508
(Rajatasilpin, A. et al., 1979)

% Body Fat for female = 22.0717 + 0.341 S + 0.4309 OW
(Viseshakul, D. et al., 1983).

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Table 5 showed that Hypertensives have higher Detection Threshold for sodium chloride than Normotensives. Fifty-five percent (40 out of 73) of Hypertensives could not experience salt from water at the concentration less than 30 m moles/L, 34 % of Normotensives (25 out of 73) showed the same condition.

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Table 5. Percentage of Hypertensives and Normotensives demonstrated their Detection threshold at various concentrations of sodium chloride solutions (m moles/litre)

NaCl (m moles/litre)	Detection threshold			
	Hypertensives		Normotensives	
	n	%	n	%
6	1	1.4	-	-
12	11	15.1	19	26.00
18	21	28.8	29	39.7
30	29	39.7	22	30.1
60	5	6.8	3	4.1
150	6	8.2	-	-
300	-	-	-	-
Total	73	100.0	73	100.0

Mode = 29.50

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Table 6 showed that Hypertensives have higher Recognition Threshold for sodium chloride than Normotensives. Seventy-one percents of Hypertensives could not experience salty test less than 60 m mols/L sodium chloride solution, while 49 percent of Normotensives could. Therefore the salt sensitivity of Hypertensives were low, or their Recognition Threshold were high.

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Table 6. Percentage of Hypertensives and Normotensives demonstrated their Recognition thresholds at various concentrations of sodium chloride solutions (m moles/litre).

NaCl (m moles/litre)	Recognition threshold			
	Hypertensives		Normotensives	
	n	%	n	%
6	-	-	-	-
12	1	1.4	-	-
18	4	2.5	10	13.7
30	16	21.9	26	35.6
60	33	45.2	26	35.6
150	9	12.3	11	15.1
300	10	13.7	-	-
Total	73	100.0	73	100.0

Mode = 63.52

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The statistical test for detection threshold for salt at below and above 30 m moles/litre was performed and significance was revealed by Chi-square test (P = 0.0197). The recognition threshold for salt at below and above 60 m moles/litre in hypertensives and normotensives was also tested, the significance was 0.0175 for P-value (Table 7.1)

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Table 7.1 Association between Detection threshold for salt at below and above 30 m moles/litre, Recognition threshold for salt at below and above 60 m moles/litre in Hypertensives and Normotensives.

Threshold for salt	Hypertensives n	Hypertensives %	Normotensives n	Normotensives %	X^2-test	df	P-value
1. Detection threshold							
< 30 m moles/litre (6-18 m moles/litre)	33	45.21	48	65.75	5.43514	1	0.0197*
≥ 30 m moles/litre	40	54.79	25	34.25			
Total	73	100.00	73	100.00			
2. Recognition threshold							
< 60 m moles/litre (6-30 m moles/litre)	21	28.77	36	49.32	5.64084	1	0.0175*
≥ 60 m moles/litre	52	71.23	37	50.68			
Total	73	100.00	73	100.00			

* Statistic significant, $P < 0.05$

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Hypertensives have higher detection threshold for salt at below and above 30 m moles/litre than Normotensives with statistic significance by Student's t-test ($P < 0.05$) the same as recognition threshold at below and above 60 m moles/litre, the significance was below 0.05 for P-value (Table 7.2).

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Table 7.2 Comparison of Detection threshold for salt at below and above 30 m moles/litre, Recognition threshold for saft at below and above 60 m moles/litre between Hypertensives and Normotensives.

Threshold for salt	Hypertensives		Normotensives		t-test	df	P-value
	n	%	n	%			
1. Detection threshold							
< 30 m moles/litre (6-18 m moles/litre)	33	45.21	48	65.75	2.633	144	< 0.05*
≥ 60 m moles/litre	40	54.79	25	34.25			
Total	73	100.00	73	100.00			
2. Recognition threshold							
< 60 m moles/litre (6-60 m moles/litre)	21	28.77	36	49.32	1.9912	144	< 0.05*
≥ 60 m moles/litre	52	71.23	37	50.68			
Total	73	100.00	73	100.00			

* Statistic significant, $P < 0.05$

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Table 8.1 showed that there was no relationship between 9 food-consumption patterns (alcoholic consumption, habit of adding fish sauce to foods, vegetable consumption, coconut milk consumption, fried food, pork, beef, chicken and egg) and the hypertensive disorders by using Chi-square test.

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Table 8.1 Relationship of selected food consumption patterns in Hypertensives and Normotensives.

Selected food consumption patterns	Hypertensives n	Hypertensives %	Normotensives n	Normotensives %	X^2-test	df	P-value
1. Alcohol consumption							
Never	22	30.14	21	28.77	2.68	2	0.2581
Sometime	34	46.57	42	57.53			
Every day	17	23.29	10	13.67			
Total	73	100.00	73	100.00			
2. Habit of adding fish souce to foods							
Adding before testing	11	15.06	14	19.17	0.4343	1	0.5146
Adding after testing	62	84.94	59	80.83			
Total	73	100.00	73	100.00			
3. Vegetable consumption							
Consumed vegetable in very meal	32	43.84	39	53.42	1.3420	1	0.2479
Sometime	41	56.16	34	46.58			
Total	73	100.00	73	100.00			
4. Coconut milk consumption							
not regular	15	20.54	24	32.87	2.8339	1	0.0945
$\geq$ 1 time/week	58	79.46	49	67.13			
Total	73	100.00	73	100.00			

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Table 8.1 Continued.

Selected food consumption patterns	Hypertensives n	Hypertensives %	Normotensives n	Normotensives %	X^2-test	df	P-value
5. Fried food							
not regular	6	8.22	11	15.07	1.6643	1	0.2130
≥ 1 time/week	67	91.78	62	84.93			
Total	73	100.00	73	100.00			
6. Pork (Fatty meat with skin) consumption							
not regular	40	54.79	49	67.12	2.3311	1	0.1409
≥ 1 time/week	33	45.21	24	32.88			
Total	73	100.00	73	100.00			
7. Beef (Fatty meat with skin) consumption							
not regular	46	63.01	46	63.01	0.0293	1	0.8765
≥ 1 time/week	27	36.99	27	36.99			
Total	73	100.00	73	100.00			
8. Chicken (Meat, Fat and skin) consumption							
not regular	37	50.68	39	53.42	0.1097	1	0.7445
≥ 1 times/week	36	49.32	34	46.58			
Total	73	100.00	73	100.00			
9. Egg							
not regular	6	8.21	8	10.95	0.3160	1	0.598
≥ 1 time/week	67	91.79	65	89.05			
Total	73	100.00	73	100.00			

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Table 8.2 When we considered food consumption patterns in term of more frequency by using Student's t-test, found that Hypertensives have higher alcohol consumption than Normotensives with statistic significance ($t = 1.6588$, $P = 0.05$). For "Coconut milk consumption" and "Fatty pork meat" were also tested, the significance were $t = 1.7030$, $P = 0.0453$ and $t = 2.6662$, $P = 0.0044$ respectively. There were no statistic significance between 6 food consumption patterns which are : habit of adding fish sauce to foods, vegetable consumption, fried food, beef, chicken and egg.

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Table 8.2 Comparison of food consumption patterns between Hypertensives and Normotensives.

Selected food Consumption patterns	Hypertensives n	%	Normotensives n	%	t-test	df	P-value
1. Alcoholic consumption							
Sometime	34	66.67	42	80.77	1.6588	101	0.05*
Every day	17	33.33(P_1)	10	19.23(P_2)			
Total	51	100.00	52	100.00			
2. Habit of adding fish sauce to foods.							
Adding befor testing	11	15.06	14	19.17	0.6600	144	>0.25
Adding after testing	62	84.94(P_1)	59	80.83(P_2)			
Total	73	100.00	73	100.00			
3. Vegetable consumption							
Consumed vegetable in very meal	32	43.84	39	53.42	1.1640	144	0.1239
Sometime	41	56.16(P_1)	34	46.58(P_2)			
Total	73	100.00	73	100.00			
4. Coconut milk consumption							
not regular	15	20.54	24	32.87	1.7030	144	0.0453*
≥ 1 time/week	58	79.46(P_1)	49	67.13(P_2)			
Total	73	100.00	73	100.00			

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Table 8.2 Continued.

Selected food Consumption patterns	Hypertensives n	%	Normotensives n	%	t-test	df	P-value
5. Fried food							
not regular	6	8.22	11	15.07	1.2998	144	0.0975
≥ 1 time/week	67	91.78(p_1)	62	84.93(P_2)			
Total	73	100.00	73	100.00			
6. Pork (Fatty meat with skin) consumption							
not regular	40	54.79	49	67.12	2.6662	144	0.0044*
≥ 1 time/week	33	54.21(P_1)	24	32.88(P_2)			
Total	73	100.00	73	100.00			
7. Beef (Fatty meat with skin) consumption							
not regular	46	63.01	46	63.01			
≥ 1 time/week	27	36.99	27	36.99			
Total	73	100.00	73	100.00			
8. Chicken (Meat, Fat and skin) consumption							
not regular	37	50.68	39	53.42	0.3425	144	>0.25
≥ 1 time/week	37	49.32(P_1)	34	46.58(P_2)			
Total	73	100.00	73	100.00			
9. Egg							
not regular	6	8.21	8	10.95	0.6850	144	0.2467
≥ 1 time/week	67	91.79(P_1)	65	89.05(P_2)			
Total	73	100.00	73	100.00			

* Statistic significant, $P < 0.05$

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CHAPTER V

DISCUSSION AND RECOMMENDATION

1. Genetic Predisposition in Hypertension

Much had been quoted on genetic predominant in hypertension as noted on the review-lileratures, our study gave the evidance of genetic influence among Thais. A cardiovascular risk-factors survey undertaken on this same population (1331 males & females), revealed of 21.4 percents reported to have history of hypertension in family, and the prevalence rate of hypertension found in this population group to be 8 percents (Viseshakul et al., 1979). The prevalence rate of Thai rural population (4915 male and female) reported one year later to be 2 percents (Uraiwan et al, 1978) contrary to the very rare in other primitive populations from many parts of the world. It is true that those who have genetic predisposition are susceptable to various environmental risk factors. Identification of those factors are necessary for the prevention of this disorder.

2. Obesity in Hypertension

Interesting, this study revealed a high statistic significance of relationship between Hypertensives with two indices (BMI, % BF) of body adiposity, either when considered sexes as combined or separated. For the criteria of using BMI as index of obesity, very

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few literatures had evaborated on this topic. We then complied a table (Table 9) of BMI corresponding to 100 percents and 120 percents of relative weight from Jelliffe's weight and height table (WHO's monograph Series 53, page 230-241, 1966).

Table 9

Ht	100% Relative Weight				120% Relative Weight			
	Weight		Body Mass Index		Weight		Body Mass Index	
	Male	Female	Male	Female	Male	Female	Male	Female
145	51.1	47.5	24.3	22.59	61.32	57	29.16	27.11
150	54.5	50.4	24.22	22.44	65.4	60.48	29.06	26.88
155	52.7	53.1	23.80	22.10	68.64	63.72	28.57	26.52
160	60.5	56.2	23.63	21.95	72.6	67.44	28.35	26.34
165	63.5	59.5	23.32	21.85	76.2	71.4	27.98	26.22
169	65.9	62.1	23.07	21.74	79.08	74.52	27.68	29.09

At standard weight (100% relative weight) the BMI showed to be $\approx$ 24 for males and 22 for females, and to be independent from height, the nature of independency could also be found for the obesity (120 % relative weight), 28 for males and 26 for females. Many studies on various statistic techniques claimed that the BMI had high correlation with weight but total independent to height (Billewicz, W.Z. et al., 1962), thus can be used to define obesity. However this index had no account on body muscularity and body structure. For male Hypertensives and Normotensive

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whose BMI were within non-obese criteria (24.5), however the statistical significant association had existed. The significance was shown to be higher for female Hypertensives in our study, which showed high prevalence of hypertension among females. The result can be used to stress on obesity may be one major risk factor for hypertension, more particular to female. The mechanism that obesity cause hypertension is not well understood, but it has been accepted that in obesity, the vascular system is not increase with the weight, thus giving cardiac loading. It is also viscious cycle as the blood pressure rise as weight increase, and low activity of Hypertensives cause increasing weight. Weight reduction can lower the blood pressure.

The BMI had been accepted widely at the present time to reflex obesity, even it did not quantify the magnitude of body fat. From our study percentage of body fat were also estimated according to our suggested equations for separated sexes, the figures showed 41 and 33 percents in female Hypertensives and Normotensives respectively, but for males the percentage of body fat were within non-obese level. These figures may be overestimated due to the equations used were computed from a group of young adult Thais females this can not be in generalised use (Viseshakul et al., 1983).

Nevertheless, the importance of not increasing weight in individuals of high genetic predisposition may be high beneficial for the prevention, and reduction of weight for the obese Hypertensives is a must. Obesity are known to become problems in urban Thais, but not in rural population.

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3. Salt Taste Threshold in Hypertansion

Attemp to demonstrate the possible relationship of salt intake to the development of hypertension, the studies of "DTS" and "RTS" were undertaken in this study. We found that both modes of both thresholds for salt were elevated in Hypertensives as compared to controls. The increase in the threshold should reflect logically the increase of salt intake. We did not include the study either in quantifying the amount of salt consumption or the urinary excretion for sodium, but using the questionnaire on "addition of salt to foods" instead. Our data found no statistic association existed between degree of addition of salt in Hypertensives while they experienced the elevation of both thresholds. It can be explained that the elevation of the threshold was the result of lower sensitivity for salt test, so the subjects could not taste salt as well, forcing them to consume more of the salt. We had followed the Henkin's drop technique, rather than the sip and spit "technique of" Fallis, our modes of DTS/RTS were 30/60 mmHg in Hypertensives compared with 12/30 mmoles/litre of salt solution in Henkin's report. 54.7 percents of our Hypertensives could not detect salt solution differentiate from water (DTS) at the concentration below 30 mmoles/litre, by the time only 34 percents experienced the Normotensives. This figures gave high statistic significance ($P = 0.0197$) when used chi-square test. Fourty-five percents of Hypertensives had normal "DTS". Henkin found that there

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was no difference of "DTS" in Hypertensives compared with the controls, but the "DTS" was elevated in Aldosteronism.

When consider the "DTS" in group, there were 54.79 percents of Hypertensives who could not detect salt from water at the concentration below 30 m moles/L, compared with 34.25 percents of Normotensives. If we look at the figures, there were 33 Hypertensives out of 73, that had normal thresholds. Could it be that in some types of Hypertensives, the excessive salt consumption might not be the cause of the disorder, or because of the reliability of the test. Many factors that had influences on the precision of the method, they could be

1. The drop method could give higher threshold than the sip and spit method, due to smaller area of the test stimulus in the drop method.

2. The effects of after meals, duration after last smoke, and the effect of medications, these could modify the threshold.

3. The effect of different salt concentrations of saliva of subjects, the high concentration gives lower threshold. The rinsing of month were recommended before the test begun.

4. The adaptation developed differently in individuals. One who was subjected to repeated stimuli will increase the threshold.

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5. The temperature of the stimuli. The test was recommended with the ambient temperature.

Then, for those hypertensives who had normal threshold, could they be the normal or low rening Hypertensives who did not develop Hyperaldosteronism, and this type of hypertension, the excessive salt consumption may not be critical. Henkin reported low Na/K ratio in saliva of Hyperaldosteronism patients, and this low ratio give high thresholds.

In this study, we did not get the salt craving behavior to confirm for the elevated threshold. Could it be the low reliability of the questionair type of asking salt addition to food, therefore more precised methods needed, such as salt preference technique according to Richter, or urinary sodium excretion.

The last notion is that the high threshold is the result of Hyperaldostersnism rather than the cause of disease. But many evidences showed that the blood pressure could be normalized with the low salt diet alone.

All the above discussion could be applied to the elevation of "RTS" as well. There were more Hypertensives (71.2 %) who had "RTS" comparable to Normotensives.

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The study on taste thresholds is an psychophysiological type and subjected to some bias that may incurred from both investigators and subjects. Some of the reviewed literatures did not shown an elevation of taste threshold for salt in hypertension, it may be due to the lack of uniformity of the methods (Fillis et al., 1962; Wotman et al., 1976; Schecher et al., 1974; Lauer et al., 1976 and Henkin et al., 1971-1974).

More further study should extend to the identification of those sodium-sensitive Hypertensives, who will give high response to the sodium restricted diet while sodium resistant Hypertensives will not. Only the sodium-sensitive types may show the high taste threshold for salt.

4. The food Preference petterns.

Much have been discussed on the reliability and precision of the methods of studying of life styl and food habits in relation to disease in human. The food weighing and food analysis is most accurate but time consumming, tedious and expensive, while the 24 hour recall as well as 3 or 7 days recall depends on the memories and the intelligence of the subjects. Both self-recorded and interviewed typed of questionnairs can only be done in more co-operated types of subjects to give high reliability, however the interpretation of the obtained results depend on the accuracy and the strike to the point of the designs of the questionnairs.

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For the alcoholic consumption aspect, our questions were divided into 3 degrees of intensity; "never" "sometime" and "every day". By using Chi square test for association, there was no association existed (Table 8.1), but if we looked upon those heavily drunk individuals and sometime, the Student's t-test showed that there were more heavy drinkers among Hypertensives than Normotensives (33.33 % in Hypertensives VS 19.23 % in Normotensives, $t = 1.6588$, $P = 0.05$) (Table 8.2). This study agreed with several studies which indicated that heavy drinkers have approximate twice the prevalence of hypertension (Spritz, N., 1979).

In accordance to the aspect of high fat, high protein concumption (HFP), our questionnairs were designed into 2 degrees of intensity; "not regular" and "$\geq$ 1 time/week". The food pattern were interviewed into "Coconut milk consumption", "Fried food consumption", and "Fatty meat (pork, beef, chicken) consumption". By using Chi-square test, there was no association existed, it could be this is the normal Thai food patterns in urbanised population. The pitfall of using maximum degree of intensity of "$\geq$ 1 time/week" seemed not to be appropiate for "high consumption". However, in using Student's t-test, the data showed that Hypertensives consummed high coconut milk and high fatty pork meat ($t = 1.703$, $P = 0.0453$ and $t = 2.6662$, $P = 0.0044$ respectively) than Normotensives (Table 8.2). Thus, the food frequency type of design should be more informative and statistically appropiated.

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For the salt consumption pattern which did not go along with the result on increasing thresholds both "DTS" and "RTS", it may be due to the perception of sodium chloride test is not the same as perception of salty test of fish sauce which is the main source of intake for Thais. However, it can be noted that there is evidence of high sodium intake in Thais.

No association observed between hypertension and dietary fibre to be misled from the theory is explained. Firstly, all subjects consumed vegetables more or less depending on individual. By the investigation, the responses of questionnairs devided them into two groups. Those who relized that vegetable is necessary for life and must be served were put in the "consumed vegetable in every meal" group whereas the others who were not interested in having vegetable in meal or were not cassified as the "sometime" groups. That is, the association between hypertension and vegetable consumption has not been observed. Secondary, subjects of hypertension were instructed to consume more vegetable by physicians on the first visit.

As vegetable, the intake of egg in many form of cooking is popular among Thai people. About 90 percent of Hypertensives and Normotensives are informed to consumed eggs at least once or more in a week. Again, the statistics were not getting along with the theory. Nevertheless, egg is the popular dish on the table. Because of simple cooking, egg is immediatly imagined when housewife has no menu of the

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day. Surely, the pattern of consuming is different from that of people in developed countries. Everyone in the family shares food in the same dish. The amount of eggs taken is certainly small. Since the questionnaires were concerned general consumption and did not emphasize on consuming eggs. Then the statistical analysis did not reveal significant finding between Hypertensives and Normotensives. It showed opposite direction to the theory.

Wiehl and Reeds in 1960 suggested that food frequency technique should be appropriated. It might be suitable for epidemiology study when the test of association between disease and food was need.

In conclusion on food patterns of Thai Hypertensives, it could be noted of positive high risk of having high coconut milk consumption, and high fatty pork intake in Hypertensives.

The etiology of hypertension is multifactorial. This study confirmed that genetic predisposition exist among Thais, who would be susceptible to those identified risk factors and develop hypertension. Moreover, it has been accepted that the combination of small risk factors had more influence in the development than a single strong factor. Those factors which has been elaborated statistically from this study are : Degree of overweight in particular among females and high taste thresholds for salt. This study can not elaborate whether the elevation of the salt threshold is the result of hyperaldosteronism in some high renin hypertensive subjects, or the Thai food pattern is beneficial for the disorder as well as prevention.

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Appendix

I. The determination of percentage of body fat in male and female.

II. The statistical method used in the study.

III. Questionnairs

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I. The determination of percentage of body fat in male and female.

The estimated of body fat for male and female were calculated by using separate equation.

1. Equation for estimation of percentage of body fat for male (Rajatasilpin, A. ., et al., 1979 (53)) as following :-

$$\% \text{ Body Fat} = 70.690 \ (W/H^2 \ \%) + 0.291 \ (\text{Abd.Cir}) - 26.508$$

Where: Abd.Cir = Abdominal Cirucumference at umbilical level in vm.

W = The body weight (kg)

H = The body height (cm)

2. Equation for estimation of percentage of body fat in female (Visesshakul, D. et al., 1983 (54)) as following :-

$$\% \text{ Body Fat} = 22.0717 + 0.0341 \ S + 0.4309 \ Ow$$

Where: S = Sum of three skinfold in m.m. (tricep + abdominal + subscapular)

Ow = Percent overweight defined as percentage of excess weight from standard weight, estimated as following :

$$\text{Percent overweight} = \frac{(\text{Actual wt} - \text{Standard wt}) \times 100}{\text{Standard wt}}$$

Standard weight defined as an average weight for height from healthy female Thais. (n = 693) standard weight was calculated from the regression equation formulated as

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Wt = 0.6111 Ht - 46.5381

where :

Wt = The standard weight (kg)

Ht = The body height (cm)

This linear regression equation was obtained from weight-height of 693 healthy female Thais (510 Prasanmit Teaching College Students, 183 National Saving Bank Life Insurance data).

Examples

1. To determine % Body Fat in a male, whose height was 170 cms, whose weight and abdominal circumference was 75 kgs and 89 cms respectively. The % Body Fat could be estimated as follow.

$$\% \text{ Body Fat} = 70.690\ (W/H^2\ \%) + 0.291\ (\text{Abd.Cir}) - 26.508$$

$$= 70.690\ \left(\frac{75 \times 100}{170 \times 100}\right) + (0.291 \times 89) - 26.508$$

$$= (70.690 \times 0.2595) + 25.899 - 26.508$$

$$\% \text{ Body Fat} = 17.7361\ \%$$

2. To determine % Body Fat in female. Subject who have 70 kg body weight, whose height was 156.5 cms and three of skinfold thickness (tricep skinfold, abdominal skinfold and subscapular skinfold) were 20.2, 38 and 31 mms respectively. The % Body Fat could be estimate as follow.

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Sum of three size skinfold thickness = 20.2 + 38 + 31 mm

= 89.2 mm

The standard weight = 0.6111 Ht - 46.5381

= (0.6111 x 156.5) - 46.5381

= 49.099

$$\text{Percent overweight} = \frac{(\text{Actual weight} - \text{Standard weight})}{\text{Standard weight}} \times 100$$

$$= \frac{(70 - 49.099)}{49.099} \times 100$$

= 42.5768

% Body Fat = 22.0717 + 0.0341 S + 0.4309 OW

= 22.0717 + (0.0341 x 89.2) + (0.4309 x 42.5768)

= 22.0717 + 3.04172 + 18.3463

% Body Fat = 43.4598 %

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II. The statistical method used in the study.

1. Method of Chi-square test

For testing the association between the independent and dependent variables. Formula for calculating :-

$$X^2 = \frac{\Sigma O_{ij}}{E_{ij}} - n \quad ; \quad df = (r - 1)(c - 1)$$

where :

O_{ij} = Observed frequency in the ij^{th} cell.

E_{ij} = Expected frequency in the ij^{th} cell, which can be computed by

$$E_{ij} = \frac{O_{i.} O_{j.}}{N} \quad , \quad N = \text{total observation}$$

n = number of subject

C and R are numbers of the levels for each variables of interest.

If computed Chi-square value is greater than Chi-square value from table with degree of freedom $(r - 1)(c - 1)$ for R x C table at 0.5 significant level, there is significant associated between the independent and the dependent variables.

If the calculated value is less than X^2 values from table then there is non significant associated between the independent and the dependent variable.

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2. Method of Fisher's extact test

If expected values (E) in each cell are below 5, Fisher's exact test will be used. The formula is

$$\text{P-value} = \frac{R_1!\, R_2!\, C_1!\, C_2!}{n!\, O_{11}!\, O_{12}!\, O_{21}!\, O_{22}!}$$

where

n = number of observations

R_1, R_2 = row total

C_1, C_2 = column total

$O_{11}, O_{12}, O_{21}, O_{22}$ = number of observation categorized by row and column

3. Method of F-test

$$F = \frac{\text{large } S_1^2}{\text{small } S_2^2}, \quad \text{degree of fredom} = (n_1 - 1)(n_2 - 1)$$

in condition $S_1^2 > S_2^2$

when S_1^2 = Sample variance of first sample group

S_2^2 = Sample variance of second sample group

n_1 = Sample size of first sample group

n_2 = Sample size of second sample group

If computed F value is greater than F value from table at 0.05 significance level, the two population variances are equal ($\sigma_1^2 = \sigma_2^2$)

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If computed F value is lesser than F value from table at 0.05 significance level, the two population variences are unequal $(\sigma_1^2 \neq \sigma_2^2)$

4. Method of t-test

For testing the difference between sample means. If population variance are equal $(\sigma_1^2 = \sigma_2^2)$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{SP\sqrt{\frac{1}{n_1} + \frac{1}{n_1}}}$$

when $$SP = \sqrt{\left[(n_1 - 1)\, S_1^2 + (n_2 - 1)\, S_2^2\right]/(n_1 + n_2 - 2)}$$

$\bar{x}_1$ = Sample mean of first sample group

$\bar{x}_2$ = Sample mean of second sample group

n_1 = Sample size of first sample group

n_2 = Sample size of second sample group

If population variances are unequal $(\sigma_1^2 \neq \sigma_2^2)$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \text{ ; degree of fredom } = \frac{(S_1^2/n_1 + S_2^2/n_2)^2}{(S_1^2/n_1)^2/n_1 + (S_2^2/n_2)^2/n_2}$$

when $\bar{x}_1$ = Sample mean of first sample group

$\bar{x}_2$ = Sample mean of second sample group

n_1 = Sample size of first sample group

n_2 = Sample size of second sample group

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If computed t-value is greater than t-value from table at 0.05 significance level, there is statistical difference between the two sample means.

If computed t-value is lesser than t-value from table at 0.05 significance level, there is no statistical difference between the two sample means.

5. Descriptive statistic.

Percentage was used describing the characteristics of subjects and controls.

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III. Questionnairs

Association Between Body Adiposity, Test Aquity for Salt and Food Preference with Hypertension : A Study on National Saving Bank Cle ks.

Name ..... Age ..... Sex .....

Address .....

Part I. General charecteristics.

1. Level of education

/__/ 1. below 12 years in school /__/ 2. 12 years in school

/__/ 3. vocational level /__/ 4. university level.

2. Religions

/__/ 1. Buddhists /__/ 2. Catholics

/__/ 3. Islams

3. Marital status

/__/ 1. single

/__/ 2. married

/__/ 3. widow or devorced

4. Total number of persons in family

/__/ 1. 1 - 3 persons /__/ 2. 4 - 6 persons

/__/ 3. 6 persons

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5. Living location

/__/ 1. urban

/__/ 2. rural

6. Travelling to work by

/__/ 1. car driving

/__/ 2. bus or walking

7. Time (hrs) spent for travelling to work/day

/__/ 1. 3 hrs

/__/ 2. 3 hrs

8. Job satisfaction

/__/ 1. not satisfy

/__/ 2. satisfy

9. Heart and kidney disease known

/__/ 1. none

/__/ 2. known

10. Physical check up

/__/ 1. once longer than a year

/__/ 2. 1 - 2 times/year

11. History of hypertension in family

/__/ 1. none /__/ 2. father and/or mother

/__/ 3. nearly relative

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12. Exercise Practise

/__/ 1. regular /__/ 2. occational

/__/ 2. not at all

13. Salaries (baths/month)

/__/ 1. no answer /__/ 2. 1001 - 3000

/__/ 3. 3001 - 5000 /__/ 4. 5001 - 8000

/__/ 5. 8001 - 10,000 /__/ 6. 10,000

14. Total family income (baths/month)

/__/ 1. no answer /__/ 2. 3001 - 5000

/__/ 3. 5001 - 8000 /__/ 4. 8001 - 10,000

/__/ 5. 10,001 - 20,000 /__/ 6. 20,000

Part II. Food preference

1. Alcoholic consumption

/__/ 1. never /__/ 2. sometime

/__/ 3. every day

2. Habit of adding fish sauce to foods

/__/ 1. adding before testing /__/ 2. adding after testing

3. Vegetable consumption

/__/ 1. consumed vegetable in every day

/__/ 2. sometime

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4. Coconut milk consumption

/__/ 1. not regular /__/ 2. 1 time/week

5. Fried food

/__/ 1. not regular /__/ 2. 1 time/week

6. Pork (Fatly meat with skin) consumption

/__/ 1. not regular /__/ 2. 1 time/week

7. Beef (Fatly meat with skin) consumption

/__/ 1. not regular /__/ 2. 1 time/week

8. Chicken (Meat, Fat and skin) consumption

/__/ 1. not regular /__/ 2. 1 time/week

9. Egg

/__/ 1. not regular /__/ 2. 1 time/week

Part III. Test aquity for salt

1. Detection threshold for sodium chloride solution

/__/ 1. 6 m moles/L /__/ 2. 12 m moles/L

/__/ 3. 18 m moles/L /__/ 4. 30 m moles/L

/__/ 5. 60 m moles/L /__/ 6. 150 m moles/L

/__/ 7. 300 m moles/L

2. Recognition threshold for sodium chloride solution

/__/ 1. 6 m moles/L /__/ 2. 12 m moles/L

/__/ 3. 18 m moles/L /__/ 4. 30 m moles/L

/__/ 5. 60 m moles/L /__/ 6. 150 m moles/L

/__/ 7. 300 m moles/L

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Part IV. Anthropometry

1. Weight ..... kg.

   Height ..... cm.

   Blood pressure ..... mmHg

   Abdominal circumference ..... cm.

   Tricep skinfold thickness ..... cm.

   Abdominal skinfold thickness ..... cm.

   Sub scapular thickness ..... cm.

2. BMI = wt/Ht^2 = ...

3. % Body Fat (male)

   = 70.690 (wt/Ht^2 %) + 0.291 (Abd.Cir) - 26.508

   = ...

4. % Body Fat (female)

   = 22.0717 + 0.0341 S + 0.4309 OW

   = ...

   where

   $$\text{Relative weight (Percent overweight)} = \frac{\text{Actual wt - Standard wt}}{\text{Standard wt}} \times 100$$

   Standard weight = 0.6111 Ht - 46.5381

   = ...

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Table 10 The anthropometric measurements of 73 Hypertensives and 73 controls.

Hypertensive males					Normotensives females				
Case no	Age (yrs)	Weight (kgs)	Height (cms)	Abd.Cir. (cms)	Cases no	Age (yrs)	Wieght (kgs)	Height (cms)	Abd.Cir. (cms)
1	51	72.0	169.5	94	1	50	62	156.5	83
2	53	74.0	163	90.5	2	55	60	153.5	87.5
3	45	59.5	156.5	84	3	44	60	165.5	75.5
4	50	65.5	159	89	4	48	54.1	162.5	77.5
5	41	66.5	164	90.7	5	41	52	164.5	66
6	50	71.5	159.5	96.5	6	55	63.7	162.5	85
7	58	57.5	167	81.2	7	59	64	159.5	92
8	39	44.2	154.5	70	8	41	54	161.5	77
9	56	64.8	153	94	9	53	73	163	90.2
10	54	65.5	156.5	87	10	52	70.5	163	95.7
11	41	77.5	164	94	11	41	66	157.5	75
12	45	76.5	162.5	97.3	12	45	69.5	170.5	78.7
13	48	59.5	166	78.8	13	49	64.3	167	84.9
14	47	102.8	167.5	116.8	14	45	69.5	162.5	86.5

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Table 10 Continuted.

Hypertensive males					Normotensives females				
Case no	Age (yrs)	Weight (kgs)	Height (cms)	Abd.Cir. (cms)	Cases no	Age (yrs)	Wieght (kgs)	Height (cms)	Abd.Cir. (cms)
15	46	77.5	173	99.1	15	43	63	166	82.7
16	47	46.4	160	76	16	46	61.5	164.5	81.3
17	48	47	160.5	69.8	17	50	61.1	166.5	87.8
18	57	64	158.5	69.5	18	58	78.5	160	97.6
19	51	76	166	94	19	52	67	170.5	82.7
20	52	53	163	80.5	20	51	65	169	80.3
21	54	60	159.5	85.5	21	55	84	181	99.1
22	39	52	165	73.5	22	40	62	157	82.5
23	47	78	172	94	23	48	62	165	76.2
24	48	63.7	167	88.5	24	45	56.5	160.5	86
25	52	71	174.5	87.7	25	51	58.5	152.5	74.8
26	54	58.5	154	76	26	54	64	175	86.7
27	44	61	168	83.6	27	43	60	165	80.8
28	59	62	158	87.8	28	59	61	158	86.3

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Table 10 Continuted.

Hypertensive males					Normotensives females				
Case no	Age (yrs)	Weight (kgs)	Height (cms)	Abd.Cir. (cms)	Cases no	Age (yrs)	Wieght (kgs)	Height (cms)	Abd.Cir. (cms)
29	58	73	170	85.2	29	57	70	173	83.7
30	47	79	167	91.2	30	50	64	167	80
31	45	86.9	178.5	96.5	31	50	56.5	158	77.3
32	50	78.3	172.5	97.2	32	53	64.6	159.5	86.5
33	45	66	167	88.9	33	45	62	163	82.7
34	46	57	161	73.7	34	47	74	165	95.8
35	52	63	160	85.6	35	51	65	175	80
36	58	61	172	76.8	36	56	60	165	80
37	44	60	164	82.5	37	44	53	167	71.5
38	50	65	161	87.7	38	50	61	160	83.9
39	50	67.5	166	81.3	39	50	85	167	94
40	39	73	164	86	40	39	56	161	78.8
41	52	64	167	81.4	41	52	74	175	91.4
42	51	63	164	85.2	42	51	85	170	104.1

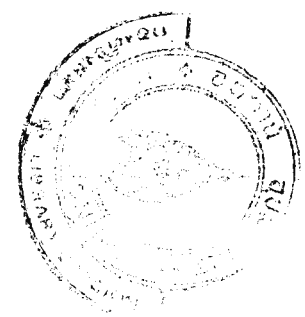

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Table 10 Continuted.

Hypertensive males					Normotensives females				
Case no	Age (yrs)	Weight (kgs)	Height (cms)	Abd.Cir. (cms)	Cases no	Age (yrs)	Wieght (kgs)	Height (cms)	Abd.Cir. (cms)
43	58	82.6	169.5	94.5	43	58	60	167	85.3
44	37	62	164	87.8	44	37	58	162	80.7
45	51	67	164	88.3	45	53	61.5	169	79.8
46	31	53	159	76.3	46	33	51	159	71
47	32	55	157	76.3	47	32	70	175	80.2
48	47	77	179	89	48	46	70	175	83.7
49	55	52.5	165	80.7	49	54	74	173	86.3
50	37	68	170	78.5	50	39	56	170	78
51	50	72	159.5	90.3	51	49	60	167	78.8
52	46	70	174	83.5	52	47	70	166	88.8
53	43	82	173	94	53	42	64	168	86.2
$\bar{X}$ =	48.11	66.51	164.7	86.18	$\bar{X}$ =	48.26	64.36	162.10	83.56
SD =	6.51	10.92	6.07	8.76	SD =	6.39	7.86	23.38	7.26

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Table 10 Continuted.

Hypertensive females							Normotensive females						
Cases no	Age (yrs)	Weight (kgs)	Height (cms)	Tricep SF. (mms)	Abd SF. (mms)	Subscapular SF. (mms)	Cases no	Age (yrs)	Weight (kgs)	Height (cms)	Tricep SF. (mms)	Abd SF. (mms)	Subscapular SF. (mms)
1	59	78.8	152	26.6	37.6	34.2	1	59	45.5	148.5	14	14.2	12.8
2	54	70	156.5	20.2	38	31	2	49	61.5	152	22.4	32.6	29
3	42	62.3	147	21.6	38.2	34.2	3	56	52.7	146	16.8	36.6	29.2
4	55	75	152	28.4	46.2	45.6	4	41	54.6	156	16.4	36.2	32.8
5	50	68.4	152.5	20.8	44.8	44	5	50	46.5	145	17	38	28.4
6	60	54	158	15	24.2	11.2	6	54	79.2	151	37.4	44	39
7	49	64.5	157	31.2	36	30.2	7	50	49.2	146	16	27.2	26
8	48	49.7	148	18.6	30.2	26.8	8	50	50.6	153	19.2	19	18.6
9	48	61.5	156.5	21.2	27	26.6	9	49	49.8	156.5	27.8	37.6	28.2
10	42	54	150.5	18	26	25.4	10	44	57	157	20.6	27	17
11	55	60.6	150.5	25.9	39.4	30	11	52	49.4	148	18.6	36.4	28.4
12	39	64.5	157	31.2	36	30.2	12	37	48	154	16.8	20	19
13	57	82.5	152	25	40.2	38	13	58	65.5	155	19.2	32.6	26

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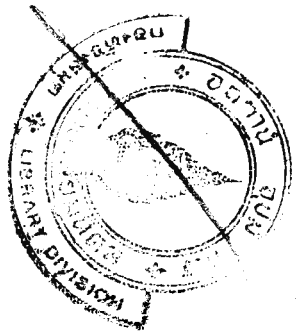
Table 10 Continuted.

Hypertensive females							Normotensive females						
Cases no	Age (yrs)	Weight (kgs)	Height (cms)	Tricep SF. (mms)	Abd SF. (mms)	Subscapular SF. (mms)	Cases no	Age (yrs)	Weight (kgs)	Height (cms)	Tricep SF. (mms)	Abd SF. (mms)	Subscapular SF. (mms)
14	51	66	154	32.4	41	33	14	53	61.5	153.5	17	36.6	33.6
15	50	63	150	24.4	39.6	33.4	15	53	57.3	155	16.2	20.8	20.4
16	59	70	149.5	29.2	45.4	40.8	16	47	47.5	145	13	25.2	22
17	46	57.3	149.5	15.8	30.8	29	17	59	45.2	150.5	19.2	36.4	25.4
18	54	54	150.5	18	26	25.4	18	55	63	155.5	16.6	43.2	40.2
19	46	66	151	28.4	38	35	19	44	53.7	152	21.6	28	25
20	56	66	151	26	38.8	32.6	20	53	58	148	26.2	39.2	36.4
$\bar{X}$ =	51	64.42	152.25	23.89	36.17	31.83	$\bar{X}$ =	50.65	54.78	151.37	19.6	31.54	26.87
SD =	6.06	8.43	3.20	5.34	6.65	7.47	SD =	5.88	8.41	4.02	5.57	8.42	7.29

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