SENSORY PREFERENCE AND DETECTION THRESHOLD FOR SALT TASTE AMONG UNDERGRADUATE STUDENTS, HEALTH CAMPUS, UNIVERSITI SAINS MALAYSIA

by

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Dissertation submitted in partial fulfillment of the requirements for the degree of Bachelor of Health Science (Honours) (Nutrition)

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MAY 2017

CERTIFICATE

This is to certify that the dissertation entitled "SENSORY PREFERENCE AND DETECTION THRESHOLD FOR SALT TASTE AMONG UNDERGRADUATE STUDENTS, HEALTH CAMPUS, UNIVERSITI SAINS MALAYSIA" is the bona fide record of research work done by Miss "NURUL HUSNA BINTI ABDUL RAZAK" during the period from September 2016 to May 2017 under my supervision. I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment for the degree of Bachelor of Health Science (Honours) (Nutrition).

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research and promotional purposes.

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NURUL HUSNA BINTI ABDUL RAZAK

21ST MAY 2017

PENGESANAN AMBANG DAN KECENDERUNGAN RASA MASIN DALAM KALANGAN PELAJAR IJAZAH SARJANA MUDA, KAMPUS KESIHATAN, UNIVERSITI SAINS MALAYSIA

ABSTRAK

Garam merupakan salah satu perisa makanan keperluan manusia. Kebanyakan natrium dimakan sebagai garam biasa (natrium klorida). Kira-kira 90% daripada garam ditambah semasa pemprosesan makanan, dalam makanan restoran, dalam sos dan proses memasak. Walau bagaimanapun, penggunaan garam yang tinggi berkait rapat dengan beberapa masalah kesihatan seperti tekanan darah tinggi, strok, penyakit kardiovaskular dan obesiti. Tujuan kajian ini diajalankan adalah untuk menentukan keutamaan dan mengesan ambang bagi rasa masin dalam kalangan pelajar Melayu, Cina dan India, Universiti Sains Malaysia, Kampus Kesihatan. Pengesanan ambang untuk rasa masin telah dikenalpasti dengan menggunakan tiga alternatif dipaksa-pilihan (3-AFC) manakala keutamaan untuk rasa masin telah dikenalpasti dengan menggunakan ujian hedonik. Bagi ujian ambang pengesanan, nilai kumpulan BET untuk pelajar Melayu adalah 1.564mM, 1.1854mM untuk pelajar Cina dan 0.8988mM untuk pelajar India. Hal ini menunjukkan bahawa pelajar Melayu mempunyai nilai kumpulan BET tertinggi bagi ambang pengesanan berbanding etnik lain. Bagi jantina, pelajar lelaki daripada etnik India menunjukkan pengesanan ambang tertinggi kepada natrium (1.727mM). Sementara itu, pelajar perempuan Melayu mempunyai ambang tertinggi pengesanan (2.257mM) berbanding dengan Cina dan India. Untuk pilihan utama untuk rasa masin, pelajar Melayu mempunyai keutamaan tertinggi pada natrium, iaitu pada kepekatan 0.5% w / v dan 0.375% w / v bagi pelajar Cina manakala pelajar India mempunyai keutamaan natrium yang paling tinggi, iaitu pada

kepekatan 0.375% v / w. Hal ini menunjukkan bahawa Melayu lebih gemar makanan yang masin berbanding Cina dan India. Bagi jantina, pelajar lelaki Melayu dan Cina mempunyai keutamaan yang lebih tinggi untuk rasa masin berbanding pelajar wanita. Bagi etnik India, pelajar lelaki hanya mempunyai keutamaan yang lebih tinggi bagi tiga kepekatan terendah pertama. Ambang pengesanan tidak mempunyai sebarang hubungan dengan keutamaan untuk rasa masin dalam kalangan pelajar Melayu, Cina dan India. Kesimpulannya, pengesanan ambang kemasinan, keutamaan untuk kemasinan dan hubungan antara mereka telah dapat dikenalpasti dalam kajian ini.

Kata kunci: pengesanan ambang; keutamaan; garam, hubungan; 3-AFC, ujian hedonik

SENSORY PREFERENCE AND DETECTION THRESHOLD FOR SALT TASTE AMONG UNDERGRADUATE STUDENTS, HEALTH CAMPUS, UNIVERSITI SAINS MALAYSIA

ABSTRACT

Salt is one of the human's essential food seasonings. Most dietary sodium is consumed as common salt (sodium chloride). About 90% of salt is largely added in food processing, in restaurant food, in sauces and cooking. However, high consumption of salt is highly related with several health problems such as hypertension, stroke, cardiovascular disease and obesity. The purpose of this study is to determine the preference and detection threshold for saltiness among Malay, Chinese and Indian students of Universiti Sains Malaysia, Health Campus. Detection threshold for saltiness was determined by using the three-alternative forced-choice (3-AFC) while the preference for saltiness was determined by using the Hedonic Test. For detection threshold, the value of BET group for Malay students was 1.564mM, 1.1854mM for Chinese students and 0.8988mM for Indian students. These results indicated that Malay students have the highest BET group value for detection threshold compared to other ethnics. Across genders, male students from Indian ethnicity showed the highest detection threshold to sodium (1.727mM). Meanwhile, Malay female students had the highest detection threshold (2.257mM) as compared to Chinese and Indian. For the preference for saltiness, Malay students had the highest preference with sodium concentration of 0.5%w/v. Chinese students preferred sodium concentration of 0.375%w/v the most while Indian students had the highest preference of sodium, which was at concentration 0.375%v/w. These results indicated that Malay preferred saltier food compared to Chinese and Indian. Across genders, Malay and Chinese male students had

higher preference for saltiness compared to females. Meanwhile, among Indian students, males only had higher preference for the first three lowest concentrations. No relationship was found between detection threshold and preference for saltiness among Malay, Chinese and Indian students. In conclusion, detection threshold for saltiness, preference for saltiness and relationship between them were determined in this study.

Key words: detection threshold; preference; salt, relationship; 3-AFC, hedonic test

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LIST OF ABBREVIATIONS

BET	Best Estimation Threshold
DASH	Dietary Approaches to Stop Hypertension
DISH	Dietary Intervention Study of Hypertension
NaCl	Sodium Chloride
NHMS	National Health and Morbidity Survey
WASH	World Action on Salt and Health
WHO	World Health Organization
3-AFC	Three-Alternative Forced-Choice

1.0 Introduction

1.1 Background of study

Salt is generally defined as a crystalline compound (NaCl) which consists mainly of sodium chloride. It is presents abundant in nature and usually used to season or preserve food in industry. Salt and sodium is not exactly the same thing although it is often interrelated. According to American Heart Association (2016), sodium is a mineral that occurs naturally in foods or is added during manufacturing or both whereas table salt is a combination of sodium and chloride.

There are several sources of sodium present. It might occur naturally in some foods but is often added during manufacturing. Also, it might be added during cooking or served at the table. Foods such as celery, beets and milk usually contain naturally occurring sodium. Meanwhile, sodium is added during manufacturing of foods such as canned soups, lunch meats and frozen dinners.

Overall, more than 75 percent of the sodium consume widely comes from processed, prepackaged, and restaurant foods (American Heart Association, 2016). Thus, most people found it difficult to choose food with minimum sodium content because it is already added in the foods bought. Meanwhile, about 12 percent of sodium present in our diets occurs naturally in the food.

Sodium is often added to food due to its several functions. Its main function is to add flavor to food which makes food becomes more palatable. Next, it can also act as a preservative in order to keep the food longer as well as to enhance the colour of the food or giving food a firmer texture. For instance, in baking industries, sodium in the form of baking soda is helpful in making the bread and other baked goods rise.

However, international recommendation advice that average population should consume less than 5-6 g of salt per day. This is because it is believed that high salt intake could increase blood pressure which in turn leads to cardiovascular disease (CVD) such as heart disease, heart failure and stroke. Research shows that higher intake of salt, sodium or salty food is linked to an increase in stomach cancer (Health Risks and Disease Related to Salt and Sodium, n.d).

Previous studies concluded that salt, as well as salted and salty food, are a probable cause of stomach cancer. Besides CVD and cancer, high salt intake could also lead to osteoporosis. Osteoporosis is a condition in which the bone undergoes thinning process, generally caused by high salt diet. Another salt-related disease that has spread rapidly nowadays is nutrition-related non-communicable diseases (N-NCDs). In most countries of Eastern Mediterranean Region (EMR), (N-NCDs) are the most frequent cause of morbidity and mortality specifically, cardiovascular disease (CVD), diabetes and cancer.

The prevalence of hypertension is 30.3% in which has reduced by 2.4% compared to the year of 2011 (*Salt Reduction Strategy: To Prevent and Control NCD for Malaysia 2015-2010,* 2015). There are several risk factors that contribute to high prevalence of this non-communicable disease such as high blood pressure, high concentration of serum cholesterol, tobacco smoking, unhealthy eating habits, overweight or obesity as well as physical inactivity. Demographic and socioeconomic status are among the factors that possibly linked to N-NCDs in this region. (Musaiger & Al-Hazza, 2012).

Several epidemiological and clinical studies have demonstrated a clear relationship between salt intake and hypertension (Al-Solaiman *et al*. 2009). Based on

previous studies, humans are classified as salt-sensitive (SS) and salt-resistant (SR). It is based on their blood pressure responses to different sodium balance. Oxidative stress acts as the main roles in the pathogenesis of hypertension. People who have hypertension usually have low level of antioxidant and increased oxidative stress in their body. In an experimental model of salt-sensitive hypertension, high salt intake increases markers of vascular and systemic oxidative stress (Al-Solaiman *et al*. 2009). Consumption of too high salt can also impair vascular dilatation by decreasing nitric oxide in both salt-sensitive animals and humans. However, both the acute and intermediate-term studies of sodium loading and depletion showed that there are some differences in terms of markers of oxidative stress between salt-sensitive and salt-resistant subjects.

An eating plan that is believed can lowers blood pressure is called the Dietary Approaches to Stop Hypertension (DASH). It is can be more efficient when combined with low salt intake diet. DASH eating plan is a flexible and balanced eating plan which helps to create a heart-healthy eating style for life. Generally, it does not require any special foods. In turns, it provides one's daily and weekly nutritional goals. DASH eating plan recommends individuals to eat more vegetables, fruits and whole grains. It also includes fat-free or low-fat dairy products, fish, poultry, beans, nuts as well as vegetable oils.

Besides that, DASH also encourages individuals to limit their intakes of food which is high in saturated fat including fatty meat, full-fat dairy products and tropical oils. Tropical oils that contain high saturated fat include coconut oil, palm kernel and palm oils. Furthermore, previous studies reported that DASH diet improves antioxidant capacity and have the potential to reduce oxidative stress in metabolic syndrome patients with elevated blood pressure (Al-Solaiman *et al*. 2009).

1.2 Problem statement

High salt intake has become a major risk factor related to many cardiovascular and renal diseases. A new coalition has been formed namely World Action on Salt and Health (WASH) which consists of health professionals from different countries. Their aimed is to implement changes in salt consumption in their own countries with the goal of reducing blood pressure among the population. Generally, the overall prevalence of hypertension for both known and undiagnosed among adults aged 18 years and above was reported to be 30.3%. However, the prevalence is different according to geographical area. As instance, the prevalence of hypertension was significantly higher in the rural areas compared to urban areas.

According to states, Kedah has the highest prevalence with 37.5% of hypertension population followed by Sarawak at 37.3% and Perak at 36.4%. Meanwhile, Wilayah Persekutuan Putrajaya noted the least percentage of people having hypertension which is at 24.1% (National Health and Morbidity Survey, 2015). Adult population are recommended to consume less than 2000 mg of sodium which is equivalent to 5 grams of salt per day according to the new guidelines issued by WHO. According to NHMS (2014), the median sodium intake among Malaysian adults was about 1935 mg/day. Surprisingly, Malaysian men had a higher median intake of sodium at 490 mg compared to women. They also had a median intake which was higher than the overall median by about 278 mg.

The respondents in East Malaysia had higher sodium intake compared to Peninsular Malaysia which is about 2026 mg. On the other hand, urban respondents had higher sodium intake than their rural counterparts. When compared by age group, sodium intake range from highest in the 30 to 39 years group at 2020 mg to the lowest

in 50 to 59 years group which is about 1685 mg. In most of socio-demographic group, men had consumed more than recommended level of sodium intake than women.

Most people are aware about the existence of strong relationship between high salt consumption and hypertension. In addition, many previous studies have proven this relationship. However, there was other few studies found that the relationship is not universal. For example, a study published in 1994 in the American Journal of Hypertension demonstrated that lowering salt intake reduces blood pressure in normal weight people, but in overweight population at 110% to 160% of their ideal weight, the reduction in salt intake is not as beneficial as weight loss (Campagnoli, Gonzalez & Santa Cruz, 2012).

The Dietary Intervention Study of Hypertension (DISH) trial also demonstrated that a diet low in sodium and high in potassium reduced blood pressure, and this was especially true in non-obese patients (Campagnoli *et al*. 2012). Besides that, The Trial of Hypertensive Interventions and Management (TAIM) provide no support for the sole use of low sodium or high potassium diet as a practical therapeutic strategy in maintaining blood pressure control in moderately obese (Campagnoli *et al*. 2012). In turn, they found that low-salt diet was associated with a high rate of recidivism. Thus, sodium restriction in an individual's diet might not be a long-term therapeutic option for blood pressure control in mild hypertension.

Cocores & Gold (2009) found that adolescents tend to prefer higher levels of salt compared with adults, which parallel the thrill seeking orientation and experimentation with nicotine, alcohol and other drugs characteristics of this age group. Cowart (2010) also reported that the importance of sensory context in item-specific preferences established during childhood which then continues until adolescents. Both adolescents and adults are exposed to greater sensory exposure compared to young

children. Previous studies have found that restricted sensory exposure decreases appetite whereas greater sensory exposure will increase appetite. Industrialized societies who usually have time constraints may increase the consumption of commercially prepared salted convenience food in their diets as it is more easily to obtain.

This explains why adults who frequently consume large amounts of salty foods preferred saltier food from time to time. Increased dietary sodium directly correlates with increased calorie consumption, while decreased sodium consumption habits lowers calorie intake (Morris, 1997; Korhonen, Jarvinen, Sarkkinen & Uusitupa, 2000) Persistent salt food craving is different from an individual to another individual with regard to duration. Meanwhile, a fairly consistent increase in craving usually occur during the transition to reduced sodium diet. Mattes (1990) reported that preferred taste rapidly develops when salt is introduced to salt impoverished societal food chains.

Most of children and adult consume more salt than their actual requirement and usually the salt consumed is obtained from salted food or processed food. It was reported that more than 90% of sodium consumed by American adults comes from processed food instead of salt that was added during food preparation or at the table. Only less than 10% of dietary sodium consumed comes from the use of table and cooking salt. Besides that, stress also play important role for preference of salty food. Leshem, Maroun & Del Canho (1996) noted that social stress among industrialized cultures increases salted food consumption during childhood. The same situation also occurred during their adulthood. These and some other factors might explain why salt usage has been increasing nearly 50% from the mid-1980s to the mid-1990s.

Bertram *et al*. (2012) noted that salt can affect blood pressure (BP) via a linear association. In South Africa (SA), the community is confronting a quadruple burden of

disease. The non-communicable disease (NCD) burden have been increasing in the face of high levels of HIV, injuries and maternal and child health issue. However, NCDs always have been neglected in health priorities. For now, stroke is the third-leading cause of death in SA, followed by HIV and ischemic heart disease (Bertram *et al*. 2012). A study in SA reported that the number of CVD and fatal diseases can be avoided if the sodium content of bread, margarine, soups and gravies are reduced or minimized according to the World Health Organization (WHO) recommendation which is 4-6 g/day.

Reduction in consumption of foods high in salt content can bring positive effects to a large public health. Besides having the ability to prevent the number of death due to CVD, non-fatal strokes could also be prevented which will then relieve some pressure of the overburdened health system. Reducing salt intake may not only reduce the incidence of CVD and other non-communicable disease but household cost will also be reduced. However, further analysis from the study assumed that the consumption of other high salt foods will not increase if the salt content of targeted foods was successfully decreased (Bertram *et al*. 2012).

According to Kaplan (2000), a decrease in sodium consumption could possibly bring some benefits such as regression of left ventricular hypertrophy, reduction in proteinuria, decrease in osteoporosis especially among the elderly, protection against strokes and so on. However, too extreme of sodium restriction which is below 10-20 mmol/d is potentially to cause harmful hormonal and lipid effects such as increasing the plasma concentration of catecholamines.

However, there are very few studies that focus on the factors which determine sensory preference and detection threshold for salt taste among adolescents and adults, specifically university students. Thus, this research aimed to determine the preference and detection threshold for saltiness among Malay, Chinese and Indian students.

1.3 Research Questions

1. What is the detection threshold for saltiness among Malay, Chinese and Indian students?
2. What is the salt taste preference in food matrices among Malay, Chinese and Indian students?
3. What is the relationship between detection threshold and preference for saltiness among Malay, Chinese and Indian students?

1.4 Objectives

1.4.1 General Objective:

To determine the preference and detection threshold for saltiness among Malay, Chinese and Indian students.

1.4.2 Specific Objectives:

1. To determine the detection threshold for saltiness among Malay, Chinese and Indian students.
2. To determine the salt taste preference in food matrices among Malay, Chinese and Indian students.
3. To determine the relationship between detection threshold and preference for saltiness among Malay, Chinese and Indian students.

1.5 Research Hypotheses

Hypothesis 1:

H_o**:** There is no significant difference between detection threshold for saltiness among Malay, Chinese and Indian students.

H_A**:** There is significant difference between detection threshold for saltiness among Malay,Chinese and Indian students.

Hypothesis 2:

H_o**:** There is no significant difference between salt taste preference in food matrices among Malay, Chinese and Indian students.

H_A**:** There is significant difference between salt taste preference in food matrices among Malay, Chinese and Indian students.

Hypothesis 3:

H_o**:** There is no relationship between detection threshold and preference for saltiness among Malay, Chinese and Indian students.

H_A**:** There is a relationship between detection threshold and preference for saltiness among Malay, Chinese and Indian students.

1.6 Significance of the Study

High preference to high-salt food has shown to develop ample of disease such as hypertension. This is because high-salt food is able to increase the rate of blood pressure in an individual. The level of detection threshold of a person plays important role in his or her health. Previous research has shown that individual who have high detection threshold for salt taste sensitivity tend to eat saltier food than those who have low detection threshold for salt. , By conducting this research, the sensory preference and detection threshold for salt taste among university students aged between 19 to 25 years old can be determined.

A few studies from previous research found that the ability to detect sensory preference is higher during adolescent and adulthood. In this study, detection threshold for some ethnics such as Malay, Chinese and Indian students was assessed. Thus, which ethnic with higher risk to develop high-salt disease can be determined. This could create awareness among the population about the relationship between high-salt intake and high-salt related disease. The findings of the study could also be implemented in the future intervention guidelines in order to reduce the incidence of high-salt related disease in Malaysia.

1.7 Conceptual Framework

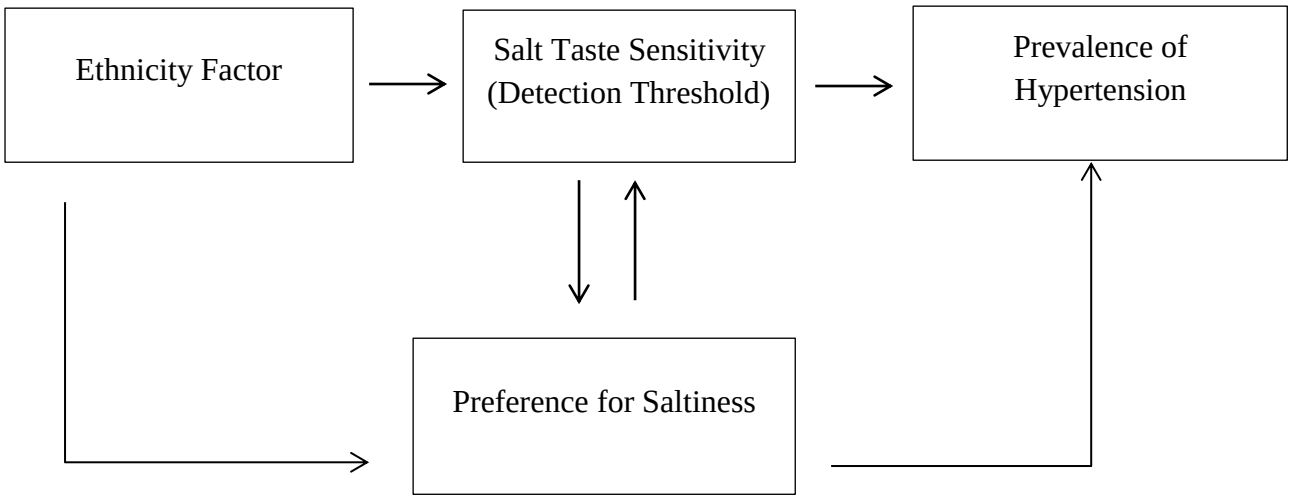

Figure 1: Conceptual Framework

2.0 Literature Review

2.1 Detection threshold for salt taste

Mattes (1984) found that the detection thresholds of primary tastes (sweet, salty, bitter and acid) are determined by the oral use of different solutions (generally placed on the tongue), in which individuals initially taste the lowest concentration of the gustatory component, followed by more concentrated solutions until a distinct taste from water is reported. However, until now, only little is known about salt taste perception and its relationship with nutritional status (Mattes, 1984; Kirsten & Wagner, 2014). Kirsten & Wagner (2014) found that the consumption of high sodium foods is considered an independent risk factor for increased cardiovascular disease development and correlates positively with an increased prevalence of systemic arterial hypertension.

In a study done by Kirsten and Wagner (2014), a relationship was not found between the salt taste sensitivity thresholds and body composition, and only the diastolic blood pressure was associated with the STST. Besides, Kirsten & Wagner (2014) found that none of the other few studies that have evaluated the relationship between salty taste perception and nutritional status observed this relationship. However, according to Kirsten & Wagner (2014), salty food consumption is not only transversely associated with body weight but is also longitudinally associated with a trend of increased salty food consumption and increased body fat percentage. Thus, reducing consumption of food high in salts could bring beneficial effects to the body.

Earlier research suggested a connection between an individual's salt taste sensitivity and their acceptance and consumption of sodium rich foods (Mitchell, Brunton & Wilkinson, 2012). Meanwhile, Bertino, Beauchamp & Engleman (1982) found that the preferred levels of sodium in food are dependent on the amount of dietary sodium consumed by individuals. In other words, Durack, Alonso-Gomez &

Wilkinson (2008) found that individuals with a high sodium intake appear to require a higher sodium concentration to obtain the same taste sensation as those less sensitive to sodium.

In a study done by Okoro, Uroghide, Jolayemi, George & Enobakhare (1998), females typically have a lower dietary salt intake and thus, have lower detection and recognition thresholds than their male counterparts. Salt detection thresholds were found to differ significantly between male and female consumers (Mitchell *et al*. 2012). However, there is no significant difference found for salt recognition threshold between males and females. This study also found that female consumers are more sensitive in the detection of salty taste in water. But still, there is no gender differences found in terms of recognition threshold. Certain food and beverages do influence the taste responses which will then influence detection and recognition threshold. However, the effect can be minimized by conducting sensory analysis test.

In the previous research, it was also found that detection thresholds are weakly related to recognition threshold. This weak correlation might be due to poor reliability within tests conducted. Lower correlations might be expected because taste sensitivity can change over time (Wise & Breslin, 2013). In a staircase method, the first threshold run for a given subject began in the middle of the concentration range which is a common practice (Wise & Breslin, 2013). This would expose sensitive subjects to concentrations above their threshold, which could desensitize the system sufficiently to yield thresholds of relatively high values, consistent with higher convergence points for sensitive people (Wise & Breslin, 2013).

Meanwhile, less sensitive subjects would experience the opposite, in which their initial concentrations with the staircase method would be below their detection thresholds and could converge on relatively lower concentrations (Wise & Breslin,

2013). However, highly sensitive individuals tend to appear slightly less sensitive when tested with the staircase method whereas less sensitive subjects tend to appear more sensitive when tested with staircase method (Wise & Breslin, 2013). Weak correlations was said to show differences in both response strategy and decision criteria.

In other research, it was found that salt taste sensitivity was inversely correlated with systolic blood pressure (SBP) in control youngsters (Arguelles *et al*. 2007). However, salt taste sensitivity was only correlated with SBP among non-obese essential hypertensive (EHT) group. In addition, salt taste sensitivity did correlate with SBP among healthy, normotensive children and adolescents whose mother experienced significant vomiting during the first trimester.

Epidemiological research has shown that dietary sodium has become one of the important contributors of hypertension. The amount of salt consumed by an individual should be related in one way or another to his/ her conscious or unconscious ability to recognize it or in other words, their salt sensitivity. A significant positive relationship between blood pressure and sodium intake has also been reported in pediatric populations and confirmed by meta-analyis (Arguelles *et al*. 2007). As hypertension is an adult disease, only few signs can be detected during early years of life.

Several researchers have studied about the relationship between salt taste sensitivity and blood pressure and they had come out with different findings. Some of them managed to found positive correlation between salt perception and blood pressure but some of them did not. A cohort studies was conducted among Spanish children and adolescents in order to determine their familial salt habits, individual salt taste sensitivity and blood pressure. A behavioral test was used to assess the salt taste sensitivity (Arguelles *et al*. 2007). At the end of the study, it was found that sodium taste sensitivity was negatively correlated with systolic blood pressure. Although the

mechanism linking those two variables cannot be exactly inferred from data collected, the correlation did suggest common or related causes for salt taste sensitivity and blood pressure.

Epidemiological and experimental studies have shown that hypertension is mainly a multifactorial disease, with an important genetic component and possibly affected by some perinatal influences (Arguelles *et al*. 2007). A study which included a sample of 51 normotensive adolescents with at least one essential hypertensive parent found that the blood pressure values of the subjects are similar to those in the control group but have a lower salt taste sensitivity threshold. When age, sex and body mass index (BMI) were included as control variables in a multiple regression model, the salt taste sensitivity threshold was significantly correlated with SBP (Arguelles *et al*. 2007).

2.2 Sensory preference for salt taste

Glanz, Basil, Maibach, Goldberg & Snyder (1998) have found that sensory taste characteristics of foods are important drivers of food choice. Different preferences may lead to distinctive food patterns which in turn may be related to diet-related health outcomes (Ahren, 2015). It is proven that such food patterns develop from the early childhood and adolescents until adulthood. The European epidemiological multicenter study Identification and prevention of Dietary and lifestyle- induced health Effects in Children and infants (IDEFICS) which addressed dietary, lifestyle, social and environmental determinants of children's health created a novel framework for the assessment of sensory taste perceptions of pre-adolescent children (Ahren, 2015).

The study is conducted to investigate the determinants of taste perceptions and how it associated with health outcomes such as obesity in childhood. It involved more than 16,000 children aged between 2 to 9 years old in countries such as Italy, Estonia,

Spain, Belgium and Hungary. The main aim of the study was to identify factors associated with taste preference and taste sensitivity. For optimal standardization, all of the juices and test crackers for the preference tests were produced centrally before being shipped to all study locations. A standard operating procedure (SOP) was worked out to ensure standardization of all tests across study centers and field staff as well as to minimize measurement bias (Ahren, 2015).

For sensory preferences, it was found that most children involved in the study preferred food sample with added flavouring salt and 34% of the children preferred to consume cracker with added MSG compared to natural cracker. The preference for the salty cracker is highest in Estonia and lowest in Cyprus and Italy (Ahren, 2015). From the study, it was found that the strongest factor related to preferences for all four taste qualities is the country of residence among participants. However, no sex differences are observed for any of the taste qualities, but taste preferences are differ by age (Ahren, 2015). Preference for salt increased with age but the result was vice versa for MSG. In addition, factors such as parental education, early feeding habits, TV watching, food reward as well as taste threshold were not consistently related to taste preferences.

Taste preference has been historically defined as the quantitative likeliness that an individual will prefer the taste of a particular food substance to another (Gaylor, 2016). Stone & Pangborn (1990) have investigated the correlation between personality type and taste preference for salty and sweet food items in a university student population. They found that individuals who scored high in extraverted behavior had consistent hedonic response to sweet taste compared to salt taste. For hedonic response of salt taste, Likert-type scale of like or dislike was used to assess the participants' score. However, a study done by (Gaylor, 2016) reported that their analysis to detect a

statistically significant positive relationship between prosocial personality type and sweet taste preference was a failure. Although they failed to find a significant positive correlation between taste preference and personality type response score, the overall positive trend in the data is consistent with the significant positive correlational findings reported in previously published studies (Gaylor, 2016).

In a study investigated by Ventura & Worobey (2013), strong correlations have been found between food preferences during early childhood and preferences in later childhood, adolescence and adulthood. They also concluded that early experience is the foundation for food preference development across the life course. They also highlighted that both taste and flavor preferences are the primary drivers of food preferences during early life. Food preferences are also known as the strongest predictors of young children's food acceptance. The first factor that had been mentioned to have relationship on food preference is biological influences, specifically genetic influence. Preferences of protein foods, fruits, vegetables and desserts are proved to be partially heritable. Recent research had resulted that salt taste are transduced by ion channels in taste receptor cells.

. Bartoshuk & Beauchamp (1994) found that preferences for taste stimuli appear to be strongly influenced by innate factors. These innate factors are believed to be present in utero. Previous researchers have used indirect strategies such as measurement of fetal response to chemical input and study of premature infants as a proxy for fetal development, in order to understand affective responses to taste stimuli in utero. Besides, food neophobia is also one of the important factors that influence food preference among children.

Food neophobia is generally defined as an unwillingness to eat novel foods. It is thought to be an adaptive behavior, to ensure that the children are consuming foods that

are familiar and safe during their developmental period as it is the period in which they are exposed to vast numbers of new foods. Rozin *et al*. (1986) reported that dislike of sensory characteristics of a food had been the strongest driver of neophobia in young children which might then lead to potential harm or sickness. In addition, repeated exposure to food allowed a particular child to accept and prefer foods available within his or her particular environment.

Besides biological influence, social influence also plays role on food preferences especially among children. Social influence initially began during early sensitive periods for flavor learning. Within this period, both amniotic fluid and breast milk contain tastants and odor volatiles from the mother's dietary and environmental exposure such as garlic, carrot and alcohol (Mennella *et al*. 2009). These flavours influenced the infants' feeding behavior and preferences after birth and during weaning when repeatedly presented to the infants'. Therefore, flavours within both the amniotic fluid and breast milk may help to guide infants towards flavours that will soon be experienced in foods by shaping early preferences (Ventura & Worobey, 2013).

2.3 Relationship between detection threshold and preference for saltiness

Brown, Tzoulaki, Candeias & Elliott (2009) reported that high dietary salt intake can lead to increased blood pressure in both patients with hypertension and individuals with previously normal blood pressure. Consumption of high dietary salt intake could lead to pathological effects in coronary artery disease, stroke and progressed renal failure. However, people found it difficult to restrict salt intake in their daily intake due to some reasons. One of them is insensitivity to salt taste. People tend to increase their dietary salt intake if they cannot detect a salty taste. Some ways were

usually used to evaluate the accuracy of gustation namely the recognition threshold, detection threshold and salt preference.

Detection threshold generally refers to the concentration of salt in fluid that can be distinguished from de-ionized water, irrespective of its taste (Cho, Kim, Jeong & Kim, 2015). Meanwhile, recognition threshold indicates the lowest concentration of a solution that can be both differentiated from de-ionized water and properly identified (Cho *et al*. 2015). Myanmar population was found to have higher prevalence of hypertension compared to Korean. According to the World Health Organization (WHO) global health risks report in 2008, the age-standardized prevalence of hypertension in 7429 adults greater than 25 years old in Myanmar was 42% whereas in Korea, based on a report from the Korean National Health and Nutrition Examination Survey in 2009, the prevalence of hypertension among 5495 adults who were 30 years of age and above was 30.4% in males and 22.2% in females (Cho *et al*. 2015). From this reports, we knew that adults in Myanmar had higher salt taste thresholds and ate much saltier foods.

At the end of the study, Cho *et al*. (2015) found that parameters related to salt intake were higher in Myanmarese than in Korean adults. As we all know, use of refrigerators can slightly affect salt taste. Thus, when a person uses refrigerators, they could reduce amount of salt used as food preservative. In addition, Myanmar has hotter climate compared to Korea and this difference explained the high salt intake in adults from Myanmar. Besides refrigerator, poorer oral hygiene in Myanmar could also be associated with higher detection and recognition threshold. Cowart (2010) reported that poor oral hygiene, periodontal disease and changes in oral hygiene regimens represent obvious potential sources of taste dysfunction. (Cho *et al*. 2015) reported that the prevalence of dental calculus in 12-year-old children was 40.0% in Myanmar and 24.8% in Korea.

In their current study, all parameters that can reflect the salt intake of participants were higher in Myanmar individuals, whose blood pressure also tended to be higher than in Korean individuals (Cho *et al*. 2015). However, systolic blood pressure was significantly correlated with the detection and recognition thresholds, but not with urine Na (UNa). Spot UNa could vary with daily sodium intake, whereas the detection threshold and recognition threshold cannot be changed within a short period of time (Cho *et al*. 2015). Those parameters might reflect long-term sodium intake (Cho *et al*. 2015).

As we all know, taste perception plays an important role in the determination of one's nutritional status as well as their general health. The incidence of hypertension-related disease has been globally increased nowadays. Thus, various strategies have been developed in order to educate people as an effort to decrease the intake of sodium in their daily lives. According to the previous studies available, a reduction of dietary salts tend to improve acuity of salt taste (Huggins *et al.*, 1992). Previous researches noted that the preferred level of salt in food depends on the level of salt consumed. However, it can be lowered by reducing the daily sodium intake to the recommended level.

Parents are the one who should be responsible to control and monitor their children's eating habit and food choices especially if their children are still in the primary school. This is because they still do not know the right choice of foods should be consumed. Also, they are more prone to be influenced by their peers. This is the reason why primary school children are greatly exposed with unhealthy foods and beverages such as junk foods and carbonated drinks. Therefore, school children are more susceptible to have nutritional imbalance compared to the adults. However, the

dietary habits of this age group has not yet been fixed, thus improvement is still possible (Kim and Lee, 2009).

From a study which was conducted in Korea, it is suggested that increased preference for salt taste might be influenced by the likeliness or frequent consumption of certain westernized fast food or also frequent use of fast food restaurants. Meanwhile, higher preference for soup or stew may be associated with reduced acuity of salt taste. The 2005 Korean National Health and Nutrition Examination Survey reported that teenagers in Korea rely more on fast foods compared to the other age groups (Khang and Yun, 2010). Among the secondary school students in Korea, 'taste' was the most influential criteria in choosing food items at the fast-food outlets. (Sim & Kim, 2003) suggest that Korean adolescents have already become immune to the taste of fast foods. Some other factors that drive the students to consume more fast foods are most of them are lack of nutritional knowledge and because of their choice of restaurants.

A significantly higher preference for salt was determined in frequent users of fast-food restaurants, but not in those who eat outside often (Kim and Lee, 2009). In other studies, it was reported that middle-aged females prefer lower level of salt compared to the adolescents. This study has also been supported by many other studies available. Therefore, these findings assumed that young adolescents tend to develop an increasing preference for salt taste as they aged. However, this problem could be overcome if they are given sufficient education in nutrition and being exposed to effective public policies. In addition, food manufactures could also contribute their efforts by reducing the salt content of food products. Korean people are also encouraged to reduce the frequency of consumption, the portion size as well as the degree of saltiness of soup.

Excessive intake of dietary sodium has been strongly related to hypertension and as we all aware, hypertension is the main risk factor for the development of cardiovascular disease (CVD) and stroke. Other studies also suggest that excessive consumption of sodium might lead to several diseases such as gastric cancer, decreased of bone density and increasing the rates of obesity. It is known that the main source of sodium comes from processed foods. Unfortunately, our diet is comprised of many processed foods which contribute about 80% of dietary sodium. There are a few studies which able to prove that an individual's salt taste sensitivity is highly related to their likeliness and consumption of salty foods. Perceived salt intensity and liking of salty foods has been shown to be influenced by prior exposure to decreased or increased sodium concentration (Lucas *et al.*, 2011).

Consumers are more prone to prefer high salt foods over the lower ones. In addition, the food environment nowadays has become saltier, and this makes the situation worsens as habituation to higher sodium concentrations may occur (Hill, 2004). However, in a study done by Lucas *et al. (*2011), there is no association found between salt taste recognition thresholds, liking, perceived intensity and sodium intake. This study also suggests that different factors might be involved in reducing any influence salt taste thresholds have on liking and intake of salty foods. Besides, the relationship between liking and saltiness is quite complex and it has been suggested that hedonic responses to differing sodium concentrations might be food specific (Hayes and others, 2010).

Besides hedonic response, individual variations in oral processing such as rate of mastication and time the foods have been hold in the mouth also play important roles as it will determine the extent to which sodium trapped in the food matrix is released and then only will be able to contact taste receptors. Furthermore, it has been clearly

hypothesized that the threshold testing may not be reliable. This is because the residual of sodium chloride might be left in the mouth after tasting a sodium chloride stimulus (Morino and Langford, 1978). Therefore, it is recommended to conduct an oral sensitivity study in which suprathreshold stimuli is used in foods rather than in solutions. The suggestion is supported by a current study which noted that association has been found between perceived salt intensity ratings and liking for the foods, which is more applicable to one's everyday dietary intake.

Furthermore, environment is said to show some influence on hedonic responses and intake. As instance, individuals may possess some differences in liking the same food depending on the place in which the test was conducted, whether the testing is conducted in a laboratory or in a naturalistic environment (Meiselman and others, 2000). In a previous, a positive relationship was found between saltiness intensity and liking of food as the study was conducted in a controlled laboratory setting. However, in another study, saltiness had no impact on hash brown liking or intake although the environment was modified to achieve a more natural eating environment. These findings may be related to some possible reasons. For example is the sample size of the hash brown. This is because the saltiest hash brown is most liked only when consumed in small bites. After satiety has been achieved, any differences in liking between different samples might be reduced. The other possible reason is regarding the sodium content of the hash browns. It means that if the sodium component of the whole meal has been varied in order to match the sodium content of the hash browns, increase intake of sodium concentration may be determined. This study also reported that intake and liking of hash brown when taken as part of meal did not show significant effect although the sodium concentration has been reduced by 80%.

The relationship between detection threshold and preference for saltiness might also be influenced by some factors such as genetic factors and environmental factors. In a study done by (Liem *et al.*, 2011), they reported that salt taste sensitivity had no major heritable components. In other words, there is no relationship between heredity and one's sensitivity towards salt taste. They also noted that environmental factors may play bigger role in determining an individual's salt taste sensitivity. This study also revealed that individuals on a sodium reduced diet experienced increased saltiness in foods and decreased liking for high concentrations of sodium chloride in foods (Blais *et al.*, 1986). Most probably, salt taste preference may be altered due to sensory experience of salt taste instead of actual amount of sodium consumed.

Besides heredity and environmental factors, body status of an individual also might affect their sensitivity towards salt taste. In a study done among obese women, it was reported that they have a significant, twofold increase in MSG detection threshold, therefore prefer higher concentration of MSG in foods such as soup compared to the normal women. These suggest that there is a positive association between MSG intake and obesity (He K, Zhao L, Daviglus ML *et al*,. 2008). This finding might be due to the differences in the sensory perception and preference for MSG. The simplest explanation for this result is that obese women is said to prefer higher concentration of MSG in foods because they have a higher detection threshold which makes them less sensitive to MSG taste compared to the normal women. Another possible reason that influence obese women to have higher concentration of MSG is due to differences of other non-taste properties of the soup such as smell (Pepino *et al.*, 2010).

Attenuated perception of flavor in the food might be due to reduced perception of aroma components as the preferred level of MSG concentration was increased during the preference test. This could be the reason of some alteration in the sense of smell