

# Nutrition and Chronic Diseases

V. Arasaratnam

*Faculty of Medicine, University of Jaffna*

## 1. Introduction

Hunger and malnutrition are the most devastating problems faced by the world's poorest nations and affect nearly 30% of humanity<sup>1&2</sup>. Many developing countries are now facing persisting food insecurity and under-nutrition as well as emerging epidemics of chronic diseases (chronic diseases are diseases of long duration and generally slow progression), such as obesity, heart disease, hypertension, stroke, and diabetes<sup>3</sup>. Currently, 15.3 million people are estimated to die from cardiovascular diseases every year; that represents one-third of all global deaths from all causes. In the next two decades, the increasing burden of cardiovascular diseases will be borne mostly by developing countries<sup>4</sup>. The number of cases of diabetes worldwide is currently estimated to be around 150 million. In Jaffna with time the number of diabetics admitted to the hospital and attending the clinic is also increasing<sup>5</sup>. Most of the patients are affected with type 2 diabetes<sup>5</sup>. In 2000, over 6 million people died from cancer, and between 2000 and 2020, the total number of cases of cancer is predicted to increase by 73% in the developing world and by 29% in the developed world, largely as a result of an increase in the number of old people. Incidence of cancer is increasing in Sri Lanka and it is the fifth cause for the deaths in Sri Lanka<sup>6</sup>.

These recent data obtained also indicates that Jaffna is also not different from other developing countries in developing chronic diseases. Significant lifestyle changes in the second half of the 20<sup>th</sup> century have greatly contributed to the emerging epidemic of chronic diseases. Therefore it is very important to bring in the awareness on the relationship between nutrition and chronic diseases.

## 2. Illness or Wellness?

To become ill or leading a healthy life depends on an individual. Genetics, genetics & nutrition and genetics & environmental factors are likely to have effects on health and susceptibility to disease<sup>9</sup>.

## 3. How can genes and nutrition interact?

Genetic factors determine how susceptible a person is to develop a disease, whilst environmental factors determine which susceptible individuals will actually develop an illness. The genetic makeup of an individual coordinates their response to diet, and thus considers underlying genetic polymorphisms. Changes in dietary patterns may affect people in different ways because of genetic variations between individuals. While targeted dietary advice for susceptible populations or individuals is desirable, it is more practical to focus on overall environmental changes that might reduce the number of susceptible persons those who would go on to develop the diseases<sup>10</sup>.

There is good evidence that nutrients and physical activity influence gene expression and shape the genome. Gene-nutrient interactions also involve the environment. Genes define opportunities for health and susceptibility to disease, while environmental factors determine which susceptible individuals will develop illness. In view of changing socioeconomic conditions in developing countries, such added stress may result in exposure of underlying genetic predisposition to diseases.

## 4. How are chronic diseases linked to diet and nutrition?

Links have been established between dietary habits and degenerative diseases like cardiovascular diseases, diabetes type 2 and cancer. Unbalanced nutrient intakes are known to

be associated with the development of chronic diseases demonstrating that dietary chemicals have direct effects on molecular genetic processes. Therefore susceptible to chronic diseases is determined only 30% by genetic factors, while 70% is determined by other factors. Therefore keeping away from the chronic diseases is mainly in our hands.

There is dramatic increase in overall fat intake and refined foods, a corresponding reduction in the proportion of energy from starchy staple foods, accompanied by a shift from coarse grain and legumes towards more refined grains (mainly rice and wheat); greater intake of meat fish, dairy products and edible also<sup>11</sup>. The general effect is to make diet less bulking and denser in energy. On an average, the amount of food consumed per person has increased by nearly 20% between the mid 1960s and date 1990s, reactively an estimated 2803 Kcal per day<sup>3</sup>. The increase in food consumption has been accompanied by a shift in dietary energy sources away from basic foods such as cereals and fruits and vegetables & towards animal products and vegetables oils<sup>12</sup>.

## 5. How does diet affect health at different stages of life?

The risks of developing chronic diseases begin in foetal life and continue into old age. Thus, adult chronic diseases reflect the combined effects of prior exposure to damaging environments. Preventive measures can, therefore, be taken at all life stages.

### 5.1 Foetal and in early infancy

In the womb and in early infancy, several risk factors can influence susceptibility to the development of diet-related chronic diseases later in life. Slowed growth in the womb, which leads to low birth weight, affects nearly a quarter of all newborn babies<sup>13</sup>. It can profoundly influence childhood growth, survival, and physical and mental capacity, as well as increase the risk of developing diet-related chronic diseases such as

cardiovascular disease (CVD), obesity hypertension, and adult onset diabetes, stroke, later in life<sup>14-18</sup>. In developing countries low birth weight & stunting are accompanied by concurrent rapid shift in diets of mother, activity pattern & obesity<sup>11,19&20</sup>. In Sri Lanka low birth weight observed in 1990 was 25% while stunting prevalence was 20.8%<sup>21</sup>.

Unusually large size at birth, possibly resulting from over-nutrition in the womb, has been linked to an increased risk of diseases such as diabetes and cardiovascular diseases.

### 5.2 Breastfeeding

**Breastfeeding** has lower risk of developing obesity in later life than those fed with other milk preparations for instance infants fed with formula milk may increase the risk of developing several chronic diseases, such as type 1 diabetes and cancer, in childhood and adolescence. The level of cholesterol and specific type of fatty acids present in the milk fed to babies are thought to affect the maintenance of cholesterol levels in later life<sup>22</sup>.

**5.3 During infancy and childhood**, both delayed growth and excessive weight or height gain has been shown to contribute to chronic disease in later life. For instance, infants with a low weight or short stature may experience an increased risk of coronary heart disease, stroke, or diabetes. Shorter children who gain height particularly quickly have an increased risk of stroke and certain cancers.

### 5.4 Childhood and adolescence

During childhood and adolescence, the adoption of habits such as unhealthy diets, low-levels of exercise, as well as alcohol and tobacco use has been shown to increase the risk of developing certain chronic diseases<sup>23</sup>.

An unhealthy diet contributes to high blood pressure in children causing changes in the body



which are associated with the risk of developing cardiovascular disease and obesity. A high calorie intake in childhood is also linked to an increased risk of cancer in later life. Worryingly, not only do chronic diseases occur earlier and earlier in life, but they tend to persist throughout life.

## 5.5 Adulthood

Most chronic diseases are expressed in **adulthood**; therefore, it is a critical time for reducing risk factors and increasing effective treatment. Risk factors that prevail during adulthood have been strongly linked with cardiovascular disease and diabetes including tobacco use, obesity, physical inactivity, high cholesterol level, high blood pressure and alcohol consumption. An individual's ability to take control over his or her life and to make healthy lifestyle decisions appears to be an important determinant of health.

## 5.6 People older than 60

The main burden of chronic diseases is observed in **people older than 60**. Cardiovascular disease, type-2 diabetes and some cancers are most common at this stage in life. This is mainly due to multiple disease processes combining with age-related losses in physiological functions. As the risk of developing disease is generally believed to be reversible at any age there is an absolute benefit for ageing individuals to eat healthily, maintain their weight, and continue to exercise.

## 6. Diet induced chronic diseases

### 6.1 Excess weight gain and obesity

While over weight and obesity are most common in developed countries, almost all countries are now affected by this worldwide epidemic, as diets are becoming richer and people more inactive. The increase in the number of cases of excessive weight gain and obesity has been paralleled by an increase in some chronic diseases such as cardiovascular

disease and diabetes and some cancer<sup>11,24&25</sup>. The energy dense diets increase the risk of overweight and obesity is does physical in activity<sup>11,26-29</sup>. Due to the transition of the dietary pattern and life style over weight and obesity are affecting the developing countries.

Within a country, the occurrence of excess weight / obesity tends to vary between certain age groups and socioeconomic classes. For example, in the most affluent countries, obesity is now affecting not only middle aged people, but also increasingly young adults and children. A study made in Jaffna has shown that 50% of the overweight adults are between the age group of 41-60<sup>30</sup>.

### How can diet and physical activity affect obesity?

Certain types of foods and eating habits have been linked to weight gain and obesity, for instance snacking, binge-eating, and eating out<sup>27&28</sup>. Physical activity and physical fitness are important factors in reducing the risk of unhealthy weight gain and related illnesses, such as heart diseases, and moderate to high fitness entails health benefits (independent of body weight).

With increasing overweight, as measured by the Body Mass Index (BMI), there is an increase in mortality rates and in the proportion of people with additional health conditions<sup>29</sup>. In one study in the USA, over half of all deaths in women with a BMI greater than 29 kg/m<sup>2</sup> could be directly attributed to their obesity. Approaches in obesity reduction will reduce the risk of other pathologies such as adult onset diabetes cardiovascular disease and certain cancer<sup>31</sup>. A body mass index of 25 in an Asian adult appears to have a far greater adverse metabolic effect than it does in a Caucasian adult<sup>32</sup>. It has been proposed a lower BMI cut off 23 for overweight and 25 for obesity for Asians<sup>33</sup> Obesity levels are higher in urban than in rural areas. Obesity levels are not associated with wealth. Householders with both undernourished and overweight women represent 3-15% of households in developing countries<sup>26</sup>.

The underweight child coexisting with an overweight non-elderly adult is a predominant poor combination/coexistence.

## 6.2 Cardiovascular diseases

Cardiovascular diseases include:

- ❖ **atherosclerosis**, which occurs when fatty deposits clog and harden arteries,
- ❖ **coronary heart disease**, caused by the reduced blood supply to the heart muscle,
- ❖ **stroke**, caused by inadequate blood flow to the brain leading to the death of brain cells,
- ❖ **hypertension**, occurs when blood pressure is higher than the normal range,
- ❖ **Cardiac arrhythmias**, which are irregular or abnormal heartbeats.

### 6.2.1 What nutrients are known to affect cardiovascular diseases?

A high intake of **dietary fats and refined foods** strongly influences the risk of developing cardiovascular disease (CVD)<sup>34-36</sup>. Restriction of calories shall reduce the risk of developing CVD<sup>44</sup>. Saturated fatty acids commonly found in dairy products and meat raise cholesterol levels. Moreover, studies have also shown trans-fatty acids, found in industrially hardened oils, increase the risk of coronary heart disease. While they have been eliminated from spreads in many parts of the world, trans fatty acids are still found in deep-fried fast foods and baked goods. To promote cardiovascular health, intake of saturated fats should be limited to less than 10% of daily energy intake for most people, and to less than 7% for high-risk groups. Products commonly used for cooking, such as hydrogenated fats or coconut and palm oil, contain saturated fatty acids. Limiting the amount of saturated fatty acids consumed can be accomplished by restricting the intake of fat from dairy and meat sources, avoiding the use of hydrogenated oils in cooking, and ensuring a regular intake of fish (once or twice per week).

The most effective replacement for saturated

fatty acids in the diet is polyunsaturated fatty acids (PUFAs) which can lower the risk of developing cardiovascular disease. In particular, they are found in soybean<sup>37</sup> and sunflower oils as well as in fatty fish and plant foods. Polyunsaturated fatty acids have many positive effects, notably on blood pressure, heart function, blood clotting, and inflammatory mechanisms<sup>38</sup>.

Cholesterol, which is an essential component of cell membranes and certain hormones, is produced by the liver, but it is also present in dairy products, meat and eggs. In the blood cholesterol is mainly transported by high density lipoprotein (HDL) and low density lipoprotein (LDL). The cholesterol carried by LDL can lead to its deposition in the arteries that can restrict blood flow and may cause heart problems. It is recommended to avoid excessive intake of cholesterol to prevent coronary heart diseases. Cholesterol is not, in fact, required in the diet because it is produced by the liver in sufficient amounts.

The studies in western population have proved that Fish consumption reduces the risk of coronary heart disease<sup>38</sup>. In one particular study, a group of patients who survived a heart attack were given fish oils over several years. Compared to patients who did not receive fish oil, this group had a 20% reduction in total mortality, a 30% reduction in cardiovascular death and a 45% decrease in sudden death. Eskimos and Japanese have less risk of cardiovascular diseases due to their consumption of cold water fish which are rich in fish fat (heart diseases and fat)<sup>39</sup>.

**Fish** consumption once or twice per week is protective against coronary heart disease and stroke. The benefits are most evident in high risk groups. For these groups, consuming 40-60g of fish per day would lead to a 50% reduction in the number of deaths from coronary heart disease. Vegetarians should ensure an adequate intake of the essential fatty acid alpha-linolenic acid which is also found in plant sources (such as canola and soybean oils, pumpkins, and walnuts).



**Dietary fibre** is also a major factor in reducing total cholesterol in the blood and LDL cholesterol in particular<sup>37</sup>. Eating a diet high in fibre and wholegrain cereals can reduce the risk of coronary heart disease.

A high intake of **salt** (sodium chloride) has been linked to high blood pressure, a major risk factor for stroke and coronary heart disease<sup>40&41</sup>. There is convincing evidence that a reduction in the daily intake of sodium (by 50 mmol, i.e about 1.2g across the world would lead to reduction in the number of deaths resulting from strokes and coronary heart disease (by about 22% and 16% respectively). Restricting **salt** intake to less than 5 g per day generally helps to reduce the risk of coronary heart disease and stroke. Restricting salt intake even more, to 1.7g of sodium per day may provide additional benefits such as helping to reduce blood pressure. However, precautions should be taken in special cases such as pregnant women who may be adversely affected by sodium reduction.

Taking potassium supplements has been shown to reduce blood pressure and the risk of CVD. However, the usual intake of fruit and vegetable consumption supplies an adequate intake of potassium and there is no evidence in favour of long term potassium supplementation to reduce the risk of CVD.

Thirty minutes of moderate **physical activity** every day may be sufficient to raise fitness of the heart and lungs which in turn may reduce the risk of CVD. A longer duration and a higher activity level would provide an even greater benefit. However, people who are generally inactive should avoid sudden and high-intensity bursts of physical activity.

### 6.3 Diabetes

Diabetes is a disease that develops when the body is unable to produce or respond to insulin in the normal way. There are two types of diabetes.

**Type-1 diabetes** is less common and associated

with a total lack of insulin. Previously known as insulin-dependent diabetes, it usually results from the destruction of the insulin-producing cells of the pancreas by the immune system. Both genetic and environmental factors seem to be involved in the onset of the disease.

**Type-2 diabetes**, previously known as non-insulin-dependent diabetes, accounts for most cases of diabetes worldwide. In this form of the disease, the body's failure to respond to insulin in the normal way leads to the overproduction of insulin, which may result in a partial failure of the insulin producing cells of the pancreas and consequently insufficient insulin production. Genetic and environmental factors determine the likelihood of developing type-2 diabetes<sup>5</sup>.

Serious complications that can result from diabetes include blindness, kidney failure, amputation, infections, coronary heart disease and stroke. In Jaffna during 2006 126 amputations and 557 surgical managements for diabetes mellitus wounds were carried out. About 63 diabetes nephropathy with chronic renal failure was also observed<sup>5</sup>. Lifestyle changes are key to both reducing the risk of developing and treating type-2 diabetes.

#### 6.3.1 What factors are known to affect diabetes?

There is convincing evidence that excessive weight gain and excess fat in the abdomen increases the risk of developing type-2 diabetes<sup>42</sup>. Excess fat in the abdomen is an important factor in the development of insulin resistance, a condition that underlies most cases of type-2 diabetes.

Children of mothers who are affected by diabetes during pregnancy are also at high risk of developing obesity and type-2 diabetes in childhood. Delayed growth in the womb and low birth weight may also increase the risk of developing resistance to insulin.

Overall, studies on humans indicate a probable causal link between saturated fatty acids and type-2 diabetes, and a possible causal



association between total fat intake and type-2 diabetes.

### 6.3.2 How could diabetes be prevented?

Specific measures can be taken to reduce the risk for diabetes, especially efforts that focus on controlling weight and preventing obesity and cardiovascular disease. Measures include:

- ❖ Avoiding weight gain of more than 5 kg in adult life and treating excessive weight gain and obesity.
- ❖ Maintaining a mean Body Mass Index (BMI) in the range of 21-23 kg/m<sup>2</sup>.
- ❖ Voluntary weight loss in overweight or obese people with higher than normal blood sugar levels.
- ❖ Engaging in at least a moderate level of physical activity for one hour or more in the course of the day on most days of the week. Exercising at 80 to 90% of maximum heart rate for at least 20 minutes five days per week may substantially improve insulin sensitivity
- ❖ Ensuring a low saturated fat intake.
- ❖ Consuming at least 20g of dietary fibre per day (i.e. whole grain cereals, fruit and vegetables).

In overweight people, voluntary weight loss enhances insulin sensitivity and reduces the risk of type-2 diabetes. Regular vigorous exercise may improve insulin sensitivity and thus reduce the risk of developing type-2 diabetes. The data collected in December 2007 indicated that 7788 adults and 11 children registered as diabetics in the medical clinics of Jaffna Teaching hospital<sup>5</sup>.

## 6.4 Cancer

Cancer is now a major cause of mortality. This is largely due to the fact that people tend to live longer, with fewer people dying from other causes such as infectious diseases. Cancer is caused by a variety of identified and unidentified factors. The most important proven cause of cancer is tobacco smoking. Other important factors include diet, alcohol consumption,

physical activity, infectious diseases, hormonal factors and exposure to radiation.

### 6.4.1 How can diet and physical activity affect the occurrence of cancer?

The likelihood of developing cancer may increase or decrease depending on what people eat how often they exercise. Dietary factors are estimated to account for approximately 30% of cancers in industrialized countries, making diet second only to tobacco as a theoretically preventable cause of cancer. Research to date has uncovered few definite relationships between specific dietary factors and cancer risk.

Factors for which there is evidence of an increased risk include:

- ❖ Obesity
- ❖ High intake of alcoholic beverages, aflatoxins (a toxic substance produced by certain molds), and preserved meat and salted or fermenting fish.
- ❖ Consuming drinks and food that are extremely hot (thermally)
- ❖ **Overall**, about 20-33% of cancers affecting the breasts, colon, uterus lining, kidney and oesophagus are attributable to unhealthy body weight and lack of physical activity.

Risk factors in developing **oral cavity, pharynx and oesophagus cancers** seem to vary between countries. In developed countries, alcohol and tobacco alone cause up to 75% of these cancers. In developing countries, 60% of these cancers are attributed to a diet low in fruits, vegetables and animal products. Throughout the world, consuming extremely hot (thermally) drinks and food increases the risk of these cancers. The observation made in Jaffna is very closer to what has been observed in the developed countries.

Studies have investigated the specific role of diet in the development of major cancers **Lung cancer** is the most common cancer in the world and over 80% of cases in developed countries are caused by tobacco smoking. The possible preventive effect of fruit and vegetables consumption

against lung cancer remains controversial. In Jaffna, water nitrate levels are very high. This may be due to the use of fertilizer in agriculture and improper sewerage system available in the North. Farmers too are not adhering to the regulations with regard to the use of pesticides and fertilizers. The farm products would be having pesticide residues, above permissible levels.

Changes in diet and nutrition may play an important role in the increasing frequency of specific cancers. Traditional and industrial food processing methods as well as microbiological and chemical food contaminants are factors that may contribute to the carcinogenicity of diets.

Although **stomach cancer** was once the most common cancer in the world<sup>43</sup>. Dietary factors are thought to play an important role and substantial evidence suggests that a high intake of salty, preserved foods can increase the risk of stomach cancer, whilst a diet rich in fruits and vegetables may reduce the risk. A bacterial infection of the stomach (*Helicobacter pylori*) is known to contribute to an increased risk.

The risk of developing cancer of the uterus lining is greater in women who are obese, probably because of changes in hormone levels. Some studies suggest that a diet high in fruits and vegetables and low in fat might reduce the risk in developing **endometrial cancer**. Overweight and obesity may cause up to 30% of **kidney cancer** cases.

**Liver cancer** occurs much more frequently in developing regions. Southeast Asia liver cancer is closely linked to certain infections (hepatitis B or hepatitis C) and to eating foods that have been contaminated by a toxic substance produced by certain molds (aflatoxin).

**Colorectal cancers** are linked with the diet, such as a high intake of fat and preserved meat or overweight, seem to increase the risk of colorectal cancer. A high intake of dietary fiber, folate, calcium, and fruits and vegetables might decrease the risk of colorectal cancer. In addition, increased physical activity has been consistently associated with a reduced rate of colon cancer.

**Cancer of the pancreas** is more common in developed countries than in developing countries. Overweight might increase the risk of developing pancreatic cancer. Moreover, the risk might increase with a high intake of meat, and decrease with a high intake of vegetables.

**Breast cancer** is the second most common cancer in the world and the most common among women. It occurs much more frequently in developed countries than in less developed countries. This may reflect differences in risk factors linked to reproduction, such as age at the onset of menstruation, age of giving birth, number of children, and breastfeeding. Differences in dietary habits and physical activity may also contribute. Although obesity affects women of all ages, it only increases the risk of developing breast cancer in postmenopausal women. Many studies have shown a small increase in risk of breast cancer as alcohol consumption increases.

Mortality rates from **prostate cancer** are ten times higher in North America and Europe than in Asia, though figures are difficult to compare between countries because of different diagnostic practices. It is not yet clear if and how diet may influence the development of prostate cancer.

#### 6.4.2 How could cancer be prevented?

The main diet and exercise-related recommendations for reducing the risk of cancers are as follows:

- ❖ *Primary Prevention*: The goal of primary prevention is to reduce or eliminate exposure to cancer causing factors, which include environmental carcinogens and life style factors related to nutrition and physical activity. This would include immunization against, or treatment of, infectious agents that cause certain cancers; use of tobacco control programmes; reduction of excessive alcohol consumption; dietary intervention and pharmacological intervention.
- ❖ Maintain a Body Mass Index (BMI) in the



range of 18.5 to 24.9 kg/m<sup>2</sup> and avoid weight gain of more than 5 kg in adult life.

- ❖ Maintain regular physical activity, such as one hour of fast walking most days of the week
- ❖ Consumption of alcoholic beverages should be avoided or limited to two glasses of either beer, wine or spirits per day
- ❖ Consumption of salt-preserved foods, preserved meats (such as sausages, salami, bacon, ham) and salt should be limited.
- ❖ Avoid eating foods that have been contaminated by aflatoxin, a toxic substance produced by certain molds.
- ❖ Eat at least 400 g of fruits and vegetables per day.
- ❖ Do not consume foods or drinks when they are at a very hot temperature.

## **7. What could be the dietary advice to the Jaffna population to avoid such chronic diseases?**

Diet largely defines a person's health, growth, and development. A shift from relatively monotonous diets of varying nutritional quality, based on the indigenous staple grain or root, locally grammars legumes, vegetables & fruits and limited food of animal origin (except any prosperous sub populations) to a relatively industrialized diets, such as high in sugars and foods of animal origin, and hence animal fat, low in starches, dietary fibers, fruits and vegetables, more processed drinks and foods, and after more alcohol. The combination of energy dense diets with physically inactive life style is an underlying factor a rapid increase in number of overweight and obese peoples. This is the basis for the development of chronic diseases. Chronic diet related diseases vary in severity and significance. These include obesity, adult onset diabetes (Diabetes Type II, insulin independent diabetes), hypertension, peripheral vascular disease and stroke, hyper lipid angina, and coronary heart disease, and a number of cancers, including those of the mouth, throat, esophagus, lung, stomach, breast, prostate, colon and rectum. Most of the diseases also have non

dietary cause, e.g. use of tobacco and lung cancer. They are also often hereditary, but any inherited genetic predisposition to disease is usually unemotional only as a result of inappropriate environmental risk factors including diet.

To avoid the diet induced chronic diseases it is important to get the basic awareness of the principles of nutrition and modify the day to day food habits with healthy diets. The average energy requirements of adult male and female along with the proportions of the energy which has to be obtained from major nutrients are given in Table 1.

### **7.1 Nutrients**

The essential nutrients include carbohydrates, proteins, fats, vitamins, minerals, fibers and water. The energy required is obtained by the oxidation of carbohydrates, proteins and fats. The vitamins and minerals are said to be accessory nutrients and are used for the metabolism of carbohydrates, proteins and fats. Fibers are indigestible substances but are beneficial to the body.

### **7.2 Energy**

Energy requirement of adults are calculated based on their basal metabolic rate, sex, age, body weight and physical activity. The western values show that average energy requirements of a male and a female are 3000 (2400-4000) and 2200 (1600-3000) kcal respectively. The studies made in Sri Lankan show that the average energy requirements of a male and a female are 2340 and 1665kcal respectively. The energy obtained by the oxidation of 1g of carbohydrate, protein and fat is 4, 4 and 9 kilo calories. It is also advised that an adult has to obtain 65-70% of energy from carbohydrates, 8-10% of the energy from proteins and 15-30% of the energy from fats. Also an adult has to consume a minimum amount of 50g of mixed proteins. Based on these values the amounts of carbohydrates, proteins and fats an adult woman and man can consume are given in table. Reduction in energy consumption can



Sex	Energy requirement (Kcal)		Carbohydrate	Protein	Fat
Male	2340	Amount (g)	380	60	65
		Energy (Kcal)	1521	234	585
		Proportion (%)	65	10	25
Female	1665	Amount (g)	270	50	43
		Energy (Kcal)	1080	200	385
		Proportion (%)	65	12	23

**Table 1:** The average energy requirements of adult male and female along with the proportions of the energy which has to be obtained from major nutrients.

reduce the development of chronic diseases and increase the life span<sup>44</sup>.

If this energy intake by an individual exceeds these values, fat accumulation shall take place leading to increase in body weight and cause the above said chronic diseases.

For a person to reduce the body weight, consumption of the energy nutrients has to be restricted. To do this and to satisfy the appetite of an individual the food has less energy density has to be consumed.

$$\text{Energy density} = \frac{\text{Energy (kcal)}}{\text{Mass of food (g)}}$$

Calorie restriction has shown to increase the life span of individuals.

### 7.3 Carbohydrate based food

Consumption of cereals and tubers, which are mainly starch based are consumed in refined form. The carbohydrates are divided into simple and complex. The simple carbohydrates are the ones which can be immediately absorbed without digestion (such as glucose or fructose-which is found in ripped fruits) or easily digested like disaccharides (table sugar or sucrose, the milk sugar-lactose). The complex carbohydrates are the products which needs time to get digested or which cannot be digested at all in human digestive system. The simple carbohydrates elevate the glucose in blood immediately and hence, leading to increased insulin secretion in the normal individual and causing easy conversion into fat

and cholesterol. But the complex carbohydrates need time to elevate the blood glucose level and they are not harmful as the simple carbohydrates. Consumption of simple carbohydrates can lead to more alarming chronic diseases when compared to complex carbohydrates. Urbanization and changes in the dietary style and introducing modern or western recipes into the day to day diets increase the chances of getting chronic diseases. Thus it is essential to avoid the simple carbohydrates as much as possible. Taking beverages and soft drinks with simple sugars are harmful. Taking Pepsi cola, Miranda, Coco Cola, etc are fashionable nowadays and can lead to bad effects. In addition these drinks also contain caffeine. Eating sweet food is another tradition and drinking coffee or tea with a large amount of sugar is also bad.

#### 7.3.1 Glycemic index

The carbohydrates which can release glucose quickly are said to cause immediate increase in blood glucose level. These foods items are said to have high glycemic index values and they have to be avoided. Further over eating of the low glycemic index foods also is not good because they can lead to high glycemic load. This means that the food with low glycemic index in large amount also can increase the blood glucose level to larger extent. Eating low glycemic index foods would be good for CVD<sup>45&46</sup> and diabetic patients<sup>47</sup>.

Any foods which have GI values less than 55 are



low GI foods, those with 55-70 are medium GI foods and with GI above 70 are high GI foods. From our recent studies the GI values obtained for the locally available foods are given in Table 2a and b<sup>48-51</sup>.

From the research findings it could be concluded that among the starch sources 'atta flour' pittu was the best followed by parboiled rice. Even though we have had a believe that kurakan and its flour are good starch based diets for diabetics and CVD patients, and obese and overweight persons. The results indicated that the foods made out of 'kurakan flour should not be recommended.

Boiled green gram and chick pea increased the blood glucose level to maximum at 1h while all the other foods considered in these studies have increased the blood glucose level to its maximum at half an hour. Further boiled green gram and chick pea showed lower GI values than all the other foods considered. Thus these two can be recommended for coronary heart disease, diabetes patients<sup>51</sup> and obese people who want to follow weight reduction programme and those have the potential to develop chronic disease.

Thus among the different types of plantain varieties, ripped 'ithari' is best followed by kappal. However among the fruits, papaya is the best followed by 'Ithari' variety of plantain.

### 7.3.2 Uses of dietary fiber in chronic diseases

Fiber is also considered to be as an important nutrient. **Dietary fibers** are the edible, indigestible portion of carbohydrate and non-carbohydrate substances. Fiber is the major constituent of plant cell wall. Fiber is the part of whole grains, fruits, vegetables, beans, nuts and. Fiber in food provides non-calorie containing bulk. Since human digestive systems contain no enzymes that can hydrolyze fibres they remain almost unchanged during their passage in the alimentary canal. Further fibre-rich foods require more chewing than do those depleted of their fibre and so put brake on the intake of energy<sup>53</sup>.

In humans, a high fiber diet aids water retention during passage of food along the gut, producing larger softer feces. Some fibers attract water into the digestive tract, thus softening the stools. Softer stools make elimination easier and reduce the pressure in the lower bowel. Some fibers speed up the passage of food materials through the digestive tract, thus shortening the time they are in the intestinal tract. This shorter time helps prevent exposure to cancer-causing agents.

In the small and the large intestine, fiber interacts with cholesterol and bile salts, and carries them out of the body with the solid wastes so that the blood lipid concentrations, such as blood cholesterol (LDL) level, are lowered. Thus the risk of gallstones and coronary heart disease is reduced.

Monosaccharides obtained by the digestion of some complex carbohydrates in the presence of fiber, produce a moderate insulin response and an even rise in blood glucose level.

Bran and whole-grain cereals and cereal products are excellent sources of insoluble fibre. Water insoluble fibre is also concentrated in stalks, seeds and skins or peelings of fruits and vegetables that we can eat. Examples of stalks, seeds and peelings of fruits include skins of apples, pumpkin, green leafy vegetables, etc.

Fibre also fights against the diseases threatening the gastrointestinal health, such as colon cancer, dumping syndrome, constipation, haemorrhoids, and even useful in the management of renal stones.

Most fiber-rich plant foods include legumes (15-19 grams of fiber per serving, including several types of beans, lentils and peas) and Asian pear (10 grams each, 3.6% by weight)

The fibre rich diets are green leafy vegetables like 'murungai leaves (which can also provide iron,  $\beta$ -carotene-precursor of vitamin A and folic acid), 'mulai keerai', 'chandi illai', ponnagkani, vallari, thavasi murungai, cabbage, sirukurncha



Foods		Glycemic Index (%)	Foods		Glycemic Index (%)	Foods		Glycemic Index (%)
Parboiled rice	Green leafy curry	47.5	Pittu (Kurakkan flour)	Green leafy curry	57.5	Pittu (Atta flour)	Green leafy curry	44.4
	Gravy	56.3		Gravy			50.8	
	Green leafy curry and gravy	54.7	Green leafy curry and gravy	59.3	Green leafy curry and gravy	46.3		
	Nil	56.0						
Sampa rice	66.6	Pittu (Rice flour and wheat flour-1:2 ratio)	43.7	String Hoppers (Rice flour and wheat flour-1:2 ratio)	50.0			
Polished Rice (At-402)	60.2							
Cassava	78.7	Potato	75.2					
Chick pea	33.3	Boiled green gram	31.4					

**Table 2a:** Glycemic Index values of different foods commonly eaten.

Foods	Glycemic Index (%)	Foods	Glycemic Index (%)
'Kappal' Plantain	54.5	'Kathali' Plantain	50.4
Papaya fruit	34.8	Jack fruit	64.4
		'Itharai' Plantain	48.5

**Table 2b:** Glycemic Index values of different commonly eaten fruits.

(*Gymnema sylvestre*) etc., ladies figure, snake gourd, string bean (they can also provide proteins), winged beans (very good source of protein), brinjal, etc, could be consumed. Papaya is the best fruit rich in soluble fibre.

#### 7.4 Proteins in the food

Protein sources eaten by the vegetarians can provide all the essential amino acids and hence eating only vegetarian diet can satisfy the protein requirement of an individual. However the biological values of the animal proteins are higher than the plant proteins. That is the animal proteins could be efficiently utilized by the human system than the plant proteins. Hence the amount of plant proteins need to be taken equivalent to the animal protein is higher.

Another important fact about proteins is that they all do not have all the essential amino acids, except egg protein. The essential amino acids are the amino acids are the ones which cannot be synthesized by the human body. Hence taking foods which would provide mixed proteins shall reduce the essential amino acid deficiencies. For example, eating cereals & legumes or cereals & meat or cereals & fish.

In the diet of the Jaffna population, cereals provide substantial amount of proteins. Adding legumes such as dhal, cow pea, chick pea, string bean, beans, soy meat, etc. shall satisfy the protein requirements.

Among the non-vegetarian dietary sources consumed by the Jaffna population, fish and country chicken are better choices than the broilers (or the birds grown in organized farms), beef and mutton. This is because the fat content is higher in broilers than in country chicken. Meat contains 22% protein. Thus consumption of beef, pork and mutton shall incorporate a high proportion of fat into the diet. Among mutton and beef, the fat removed mutton would be a better choice than beef.

Animal proteins, (even though they have high biological value) they also contribute to

homocysteine which is a non-fatty cardiovascular risk factor), and hence animal proteins have to be consumed in reduced amounts<sup>54-58</sup>.

The livestock in addition to protein provide essential micronutrients such as iron, zinc and vitamin A, pyridoxine, thiamin and riboflavin, etc. In developing countries like Sri Lanka livestock products remain a desired food for nutritional value and taste. However consumption of animal products can lead to excessive intakes of fats.

Consumption of fish is usually higher in areas that are near the coast, where alternative protein sources are lacking or where there is strong preference for fish. In Jaffna the fish and crustacean intake is more than the intake of livestock products. The amount of fish and fishing products consumption is doubled over 40 years. Fish has protein contents from 9.0 to 26% while crustaceans contain proteins from 9.8 to 25%<sup>59</sup>. Fish provides most of the essential amino acids especially lysine and methionine in high amounts.

Egg is said to contain ideal protein and have all the essential amino acids. However each egg contains 250mg of cholesterol. Therefore for a normal person, it is advised to consume two eggs per week.

#### 7.5 Fats in the food

Dietary fats include many different types of fatty acids and cholesterol. Fat contents of diets depend on the food sources. A growing proportion of fats are acquired from animal products which tend to be particularly high in saturated fats.

- ❖ Saturated fatty acids are often found in animal fats and, eaten in high quantities, can raise cholesterol levels.
- ❖ Monounsaturated and polyunsaturated fatty acids are found in nuts, seafood and certain vegetable oils and can lower cholesterol levels. Among the unsaturated fatty acids, linoleic acid and linolenic acids belong to  $\omega 6$  and  $\omega 3$  families of fatty acids and are said to be essential fatty acids.



- ❖ Trans-fatty acids are unsaturated fatty acids that behave in a similar way to saturated fatty acids. They are found in hydrogenated oils, such as margarines, and some animal-based foods and can raise cholesterol levels.
- ❖ The consumption of certain types of vegetable oils is increasing in parts of the world. In particular, in developing countries, the intake of hardened margarines (that are rich in trans-fatty acids) is increasing because they do not need to be refrigerated.

The coconut oil consumed contains 92% of saturated fatty acids and has the tendency to increase the blood cholesterol level. Gingili oil contains 47% of linoleic acid. It is one of the most unsaturated fatty acids containing oil in the world. It is also important to note that the oils/fats from plant do not contain cholesterol. Thus coconut oil, gingili oil, vegetable oil, sunflower oil, corn oil and soy oil do not contain cholesterol. However as coconut oil contains high amount of saturated fatty acid and saturated fatty acids have the tendency to increase the serum cholesterol level, coconut fat has to be avoided or reduced depending on the disease condition.

Fish oil is a good source of  $\omega 3$  and  $\omega 6$  series fatty acids. The  $\omega 3$  and  $\omega 6$  series fatty acid contents of some of the tropical fish are given in the Table 3.<sup>59</sup> Among the crustacean foods consumed, crabs and prawns (400-600 mg/100g) have high contents of cholesterol and thus have to be avoided or minimized.

Fish type		$\omega 6$ (mg/100g)	$\omega 3$ (mg/100g)
English Name	Tamil name		
Sardine	Soodai	127	1775
Indian Mackerel	Kanagnkelluthi	132	1010
Yellow fin tuna	Keerai Meen	116	699
Spanish Mackerel	Arukkula	88	431
Trevally	Paarai	30	234
Gray dog shark	Sura Meen	73	200
Skate	Thirukai	56	202
Thilapia	Kari	144	312

**Table 3:** The  $\omega 3$  and  $\omega 6$  series fatty acid contents of some of the tropical fish.

## 7.6 Other foods and nutrients

An intake of 0.8 mg of folic acid (from uncooked green leafy vegetables) could possibly reduce the risk of coronary heart disease (reduced blood supply to the heart muscle) by 16% and the risk of stroke by 24%.

There is insufficient evidence to support the theory that antioxidants such as Vitamin E (from corn or wheat germ oils), Vitamin C (from goose berry, guava, etc.) or  $\beta$ -carotene (from carrot, yellow pumpkin, mangoes) might reduce the risk of cardiovascular diseases (CVD).

Flavonoids, compounds that occur in a variety of foods such as tea, onions and apples, could also possibly reduce the risk of coronary heart disease.

Isoflavones, present in **soy products**, may provide protection against coronary heart disease.

Tea contains 30% of total dry weight green tea consumption reduced breast cancer risk.

**Coffee** beans contain a substance called cafestol, which can raise the level of cholesterol in the blood and may increase the risk of coronary heart disease.

Oat has cholesterol lowering effect due to soluble fiber  $\beta$ -glucan.

Soy plays preventive and therapeutic roles in cardiovascular diseases, cancer, osteoporosis and the alleviation of menopausal symptoms<sup>37</sup>.

Tomatoes contain lycopene, the primary carotenoid found in the fruits. Lycopene could act

as an antioxidant and reduce cancer risk.

Garlic contains an odorless amino acid, alliin, which is converted by allinase into allicin<sup>60</sup>. Allicin decomposes to form numerous sulfur – containing compounds, some of which have chemopreventive, inhibit tumorigenesis- (human cancer gene) antihypertensive property and cholesterol lowering effect.

Citrus fruits have protective effect against cancer.

## 7. Conclusion

The developing countries are facing a big challenge of increasing the risk of chronic diseases among its population, mainly due to transition in their food habits. Development of the chronic diseases could be due to genetic set up of an individual or due to the poor dietary habit or due to genetic set up, poor dietary habit and environment. Even, if a person has the hereditary tendency to develop the above said chronic diseases, the severity and complications arising from these diseases could be minimized by choosing correct nutrition. Awareness about the basic concepts about the nutrition and nutrients present in the food and cooking methods shall improve the nutritional status of an individual.

Food items which have simple carbohydrates, saturated fats, animal fats, cholesterol, should be avoided or the intake should be restricted. A diet comprising of a total fat intake of up to 35% does not increase the risk of unhealthy weight gain in physically active people who consume a lot of fruits, vegetables, legumes and wholegrain cereals.

A daily intake of 400 to 500 g of **fruits and vegetables** such as papaya, green leafy vegetables and legumes is recommended to reduce the risk of coronary heart disease, stroke and high blood pressure. This daily consumption of fruits and vegetables provides an adequate amount of potassium, which lowers blood pressure and is protective against stroke and cardiac arrhythmias. Indeed, fiber that is also found in wholegrain cereals helps to protect

against coronary heart disease and lowers blood pressure.

Eat more fish than meat. Restrict egg to two per week. Eat food with low glycemic index.

## References

1. Popkin, B. M., Horton, S. H. and Kim, S. (2001). The nutrition transition and prevention of diet related disease in Asia and the Pacific. *Food and Nutrition Bulletin*. **22** (4). United Nation Press. Japan. ISSN 0379-5723.
2. <http://en.wikipedia.org/wiki/Health>
3. Drewnowski, A. and Popkin, B. M. (1997). The nutrition transition; new trends in the global diet. *Nutrition Reviews* **55**: 31 – 43.
4. Reddy, K. S. and Yusuf, S. (1998). The emerging epidemic of cardiovascular disease in developing countries. *Circulation*. **97**: 597 – 601.
5. Sivansuthan, S. (2008). Personal communication.
6. Jeyakumar, N. (2008). Personal communication.
7. Key, T.O. (2002). The effect of diet on risk of cancer. *Lancet*. **360**: 861 – 868.
8. Gupta, P. C. and Mehta, H. C. (2000). Cohort study of all – cause mortality among tobacco users in Mumbai, India. *Bulletin of the World Health Organization*. **78**: 877 -883.
9. Simopoulos, A. P. and Pavlow, K. N. (2001). Nutrition and fitness; diet, genes, physical activity and health. World Review of Nutrition and Dietetics, **Vol. 89. Proceedings of 4<sup>th</sup> International Conference on Nutrition and Fitness, Athens, May 2000**. New York, NY. Karger
10. Navarro – Lopez, F. (2002). Genes and Coronary Heart Disease. <http://www.Revespeordiolo.org/cgi-bin/wdbeg-exe/cardio/cardioeng-inrevista-cardio.golpid>.



11. Waterland R.A. and Garza C. (1999). Potential mechanisms of metabolic imprinting that lead to chronic disease. *American Journal of Clinical Nutrition*. **69**: 179 – 97.
12. Diet. [http://en.wikipedia.org/wiki/Diet\\_%28nutrition%29](http://en.wikipedia.org/wiki/Diet_%28nutrition%29)
13. Godfrey, K. M. and Barker, D. J. P. (1995). Maternal nutrition in relation to fetal and placental growth. *European Journal of Obstetrics and Gynecology*. **61**: 15 – 22.
14. Curhan, G. C., Chertow, G. M., Willett, W. C., Spiegelman, D., Colditz, G. A. and Manson, J. E. (1996). Birthweight and adult hypertension and obesity in women. *Circulation* **94**:1310 – 1315.
15. Forrester, T. F. Wilks, R. J. and Bennett, F. I. (1996). Fetal growth and cardiovascular risk factors in Jamaican schoolchildren, *British Medical Journal* (Clinical Research Ed.) **312**: 156 – 160.
16. McDade T.W., Beck, M.A., Kuzawa, C. W. and Adair I. S. (2001). Prenatal undernutrition and postnatal growth are associated with adolescent thymic function. *Journal of Nutrition*. **131(4)**: 1225 -1231.
17. Stein, C.E., Fall, C.H.D., Kumaran, K. Osmond, C., Cox, V. and Barker, D.J.P. (1996). Fetal growth and coronary heart disease in South India. *Lancet*: **348**: 1269 – 1273.
18. Marmot M. (2001). Aetiology of coronary heart disease. Fetal and infant growth and socioeconomic factors in adult life may act together. *British Medical Journal*. **323**: 1261 – 1262.
19. Pokin, B. M., Richards, M. K. and Monteiro, C. (1996). Stunting is associated with overweight in children of four nations that are undergoing the nutrition. *Journal of Nutrition* **126**: 3009 – 3016.
20. Hoffman D.J., Sawaya, A.I., Verreschi, I., Tucker, K. I. and Roberts, S.B. (2000). Why are nutritionally stunted children at increased risk of obesity? Studies of metabolic rate and fat oxidation in shantytown children from Sao Paulo, Brazil, *American Journal of Clinical Nutrition*. **72**: 702 – 707.
21. Government of Sri Lanka. (1995). National health and nutritional survey 1995. Colombo: *Government of Sri Lanka*.
22. Cebu Study Team. (1991). Underlying and proximate determinants of child health: The Cebu Longitudinal Health and Nutrition Study. *American Journal of Epidemiology* **133 (2)**: 185 – 201.
23. Sinha, R., Fish, G., Teague, B. William R. N. Tamborlore, V. (2002). Prevalence of impaired glucose tolerance among children and adolescent with marked obesity. *The New England Journal of Medicine*. **346 (11)**.
24. Kannel, W. B., d' Agostino, R. B. and Cobb, J. L. (1996). Effect of weight on cardiovascular disease. *American Journal of Clinical Nutrition* **63** (supplement): 419S – 422S.
25. Krauss, R. M., Winston, M. Fletcher, B. J. and Grundy, S.M. (1998). Obesity: Impact on cardiovascular disease. *Circulation* **98**: 1472 – 1476.
26. Doak, C. Adair, I., Monteiro. C. and Popkin, B.M. (2000). Overweight and underweight co-exists in Brazil, China and Russia. *Journal of Nutrition*. **130**: 2965 – 2980.
27. Bray, G. A. and B.M. Popkin (1998). Dietary fat intake does affect obesity! *American Journal of Clinical Nutrition* **68 (6)**: 1157 – 1173.
28. Pi-Sunyer F.X. (1991) Health implications of obesity. *American Journal of Clinical Nutrition*. **53**: 1595S – 1603S.
29. Yajnik, C. S. (2002). The Lifecycle effects of nutrition and body size on adult obesity, diabetes and cardiovascular disease. *Obesity Reviews*. **3**: 217 – 224.
30. Luxman, A. and Balamurali, S. (2004). Problems among obese people in leading

- their normal life. Research Project in Community Medicine, Faculty of Medicine, University of Jaffna.
31. Popkin, B. M., Horton, S. U. and Kim, S. (2001). The nutrition transition and prevention of diet – related diseases in Asia and the Pacific. *Food and Nutrition Bulletin*. **22(4)**:1-58.
  32. Deurenberg, P., Yap, M. and Staveren, W. A. (1998). Body mass index and percent body fat: A meta-analysis among different ethnic groups. *International Journal of Obesity*. **2**: 1164-1171.
  33. IOTF/WHO (International Obesity Task Force/World Health Organization). (2000). *The Asian-Pacific perspective: Redefining and its treatment*. Caulfield, Victoria, Canada: International Diabetes Institute.
  34. Whorley, M. A. (2006). Mind your heart. *Analysis of Internal Medicine*. **144 (11)**: 858 – 860.
  35. Kauhanen, J. (1997). Beer bingeing and mortality. Results from the Kuopio ischaemic heart disease risk factor study: a prospective population based study. *British Medical Journal*. **315**: 846 – 851.
  36. Moza Harian, D, Rimm, E. B. and Herringon, D. M. (2004). Diets fats carbohydrates and progression of coronary atherosclerosis in post menopausal women. *American Journal of Clinical Nutrition*. **80 (5)**: 1175 – 1184.
  37. Bakhit, R. M., Klein, B. P., Essex-Sarlie, D. (1994). Soybean protein lowers LDL cholesterol. *Journal of Nutrition*. **124(2)**: 213-222.
  38. Omega-3-fatty acids and coronary heart disease. [http://care first stay well soluhonline.Com/library/wellness/1,3504](http://carefirststaywell.soluhonline.com/library/wellness/1,3504)
  39. Heart disease and food [http:// www.Healthyeating club.com/info/articles/diseases/heart.disease .htm](http://www.Healthyeatingclub.com/info/articles/diseases/heart.disease.htm)
  40. Karppanin, H., Pennanes, R. and Passinen, L. (1978). Minerals, coronary heart disease and sudden coronary death. *Advances in Cardiology*. **25**:9 – 24.
  41. Sacks, F. M., Svetkay, L. P., Vollmer, W. M., Appel, L. J., Bray, G. A., Harsha, D. Obarzanek, E., Conlin, R. R., Milller, E. R., Simons-Martin, D. G., Karanja, N. and Lin, P. H. (2001). Effects on blood pressure of reduced sodium and the dietary approaches to stop hypertension (DASH) diet. *New England Journal of Medicine*. **344**: 3-10.
  42. Tuomilehto, J. (2001). Prevention of type II diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of medicine*. **344**: 1343 – 1350.
  43. Nelson, R. L. (2001). Iron and colorectal cancer risk: human studies. *Nutrition Reviews*. **59**: 140 – 148.
  44. Park, E. J. (2001). A targeted goal for energy – restricted diets in the anagement of coronary risk. *American Journal of Clinical Nutrition*. **73(2)**: 147-148.
  45. Liu, S., Willett, W. C. and Stampfer, M. J. (2000). A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. *American Journal of Clinical Nutrition*. **71(6)**: 1455-1461.
  46. Katz, D. L. (2001). Glycemic load and the risk of coronary heart disease. *American Journal of Clinical Nutrition*. **73(1)**: 131-132.
  47. Grag, A., Bantle, J. P. and Henry, R. R. (1994). Effect of varying carbohydrate contents of diets in patients with non-insulin-dependent diabetes mellitus. *Journal American Medical Association*. **271**: 1421-1428.
  48. Raguparan, P., Thayaananthan, K., Balakumar, S. and Vasanthy Arasaratnam (2008). Determination of Glycemic index values of locally available foods in Jaffna.



- Proceedings of the 15<sup>th</sup> Annual Sessions of the Jaffna Science Association. 14: 47.***
49. Raguparan, P., Thayaananthan, K. Balakumar, S. and Vasanthi Arasaratnam (2008). Determination of the Glycemic index of the Bakery products available in Jaffna. ***Proceedings of the 15<sup>th</sup> Annual Sessions of the Jaffna Science Association. 14: 48.***
  50. Raguparan, P., Thayaananthan, K., Balakumar, S. and Vasanthi Arasaratnam (2008). Determination of the Glycemic indices of plantain varieties, ('Kathali', 'Kappal' and 'Itharai') available in Jaffna. ***Proceedings of the 15<sup>th</sup> Annual Sessions of the Jaffna Science Association. 14: 46.***
  51. Pirasath, S., Thayaananthan, K., Balakumar, S., Sivarajah, N. and Arasaratnam, V. (2008). Including curries to basic foods alter the glycemic indices. ***Proceedings of the Annual Research Symposium, University of Colombo, October, 2008, Ed. Selvakumaran, N., Constantine, G. R., De Silva, D., Randeniya, P., Olupeliyawa, A. and Wijesinghe, M. pp. 64 - 65.***
  52. Kalargis, M. (2005). The role of the glycemic index in the prevention and management of diabetes: A Review. ***Canadian Journal of diabetes. 29 (1): 27 – 38.***
  53. Dietary fiber  
[http://en.wikipedia.org/wiki/dietary\\_fiber](http://en.wikipedia.org/wiki/dietary_fiber)
  54. Wald, D. S., Law, M. and Morris, J. K. (2002). Homocysteine and cardiovascular disease; evidence on causality from a meta – analysis. ***British Medical Journal. 325: 1202 – 1205.***
  55. Yadav, A. S., Bhagwat, V. R. and Rathod, M. (2006). Relationship of plasma homocysteine with lipid profile parameters in ischemic heart disease. ***Indian Journal of clinical Biochemistry. 21(1):106 – 110.***
  56. Lias, D., Tan, H., Hui, R. L. Z., Jiang, X. Gaubatz, J., Yong, F, Durante, W, Chan, L, Schafer, A. I. Pownall, H. J., Youg, X. and Way, H. (2006). Hyperhomocysteinemia decreases circulating High Density Lipoprotein by inhibiting Apolipoprotein A- I Protein synthesis and Enhancing HDL cholesterol clearances. ***Circulation Research: 99: 598.***
  57. Eikelboom, I. W., Lonn, E., Genest, J., Hanky, G. and Yusuf, S. (1999). Homocyst(e)ine and cardiovascular Disease: A critical Review of the Epidemiologic Evidence. ***Analas of Internal Medicine. 132 (5): 363 – 375.***
  58. Foder, J. G., LeGrand, C. Homocysteine: A new coronary heart disease risk factor. [http:// www.cacr.ca/ news /1999/9909fodor.htm](http://www.cacr.ca/news/1999/9909fodor.htm).
  59. Wikramanayake, T. M. 1996.
  60. Twice – Daily garlic tablet cut triglyceride levels in diabetics. Acta Dietol 2007: Advance online publication.