

**DIETARY INTAKE OF TRACE MINERALS
(COPPER, ZINC AND CHROMIUM) AMONG SELECTED ADULTS**

BY

M. M. MANGAIANDAL

(16PFD006)

**A THESIS SUBMITTED TO
AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND
HIGHER EDUCATION FOR WOMEN COIMBATORE-641043**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN FOOD SERVICE MANAGEMENT AND DIETETICS**

APRIL, 2018

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Certified as Bonafide Research Work


Signature of the Supervisor
10.04.18


Signature of the Head of the Department
10.04.2018

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CHAPTER 1

INTRODUCTION

Trace minerals play a significant role in our body, which are required in amounts to maintain good health and optimal growth to perform physiological functions in our human body. Metals are widely distributed in the earth's crust. Many of them are essential for the normal functioning of the human body, others do not possess any known positive function being even toxic at relatively low concentrations. (Koch, et. al., 2016). Optimal nutrition, with adequate trace mineral levels, guarantees proper functions of the organism, among which the most important are structural, physiological, catalytic, and regulatory.

One of the most important determinants affecting human health is food consumption. The individual's body size, weight and all vital functions are strongly influenced by food habits, which determine the intake of all essential components, including macro and microelements. (Koch, et. al., 2016).

The term trace elements refer to chemical elements present in a natural material at very small amounts.

Trace elements refers to "Elements that occurs in natural and perturbed environments in small amounts and that, when present in sufficient bioavailable concentrations are toxic to living organism. (Prashanth, et al., 2015).

The primary role of trace elements – which are required only in minute quantities – is to provide proteins with unique catalytic, structural, or electron transfer properties. The bioavailability of specific trace elements can play an important role in several metabolic and physiological pathways which are known to be altered during the aging process. (Alis, 2016).

Trace elements have several important roles in human bodies, some are essential for enzymes reactions where they attract and facilitate conversion of substrate molecules to specific end products. Moreover, some of them donate or accept electrons in redox reactions that are of primary importance in the generation and utilization of metabolic energy. Some have structural roles and responsible for the stability of important

biological molecules. The trace elements are part of numerous enzymes and coordinate a great number of biological processes, and consequently they are essential to maintain animal health and productivity. (Soetan, 2010).

Trace minerals serve as reinforcement for bones, cartilage, and other bodily tissue. Trace minerals function as the lattice architecture. The cellular system also relies on trace minerals to produce red blood cells, also known as erythrocytes, that deliver oxygen throughout the body for energy production. Muscles and central nervous system also require trace minerals in order to facilitate nerve impulses. Without them, the muscles in heart would fail to contract, brain would stop functioning, and organs and body wouldn't be able to move or flex (Bollinger, 2015.).

A slight deficiency of trace minerals can cause a considerable reduction in performance and production. To assess the dietary intake and adequacy of minerals, information needs to be collected on mineral element content of foods, diets and water (Rao and Rao, 1981; Simsek and Aykut, 2007).

The micro nutrient elements selected in this study are Copper, Zinc and Chromium.

Copper is necessary in human nutrition for normal iron metabolism and the formation of red blood cells. Anemia is a clinical sign of deficiency of both iron and copper. Common daily intake of copper is 2 to 5mg per day is required, carried by the blood protein ceruloplasmin. (Angelova, et al., 2011).

Copper is a component in many enzymes involved in such key functions as energy production, iron metabolism, healthy connective tissue, neurotransmission, and the making of hemoglobin. Copper deficiencies can occur from malnutrition, mal-absorption or excessive zinc intake. Symptoms may include abnormal blood cells, bone and connective tissue changes, decreased immune function, bone demineralization and increased risk for cardiovascular and neurodegenerative diseases. (Gliederer, et al., 2017). Rich source of copper in foods are Grains and Legumes, Condiments, Nuts and Oil seeds, Poultry and Fish (Al-Fartusie, and Mohssan, 2017).

During the last two decades there has been concern among investigators and health regulators for the possibility that the exposure to the customary amounts of copper encountered in daily life (mainly from drinking water and food) may represent health risk for special groups in the population, especially for children (López-de-Romana. et. al., 2011).

The average amount of Zinc required is 15 to 20mg per day (Prashanth, et al., 2017). Nutrient Zinc is a relevant micronutrient involved in maintaining a good integrity of many body homeostatic mechanisms, including immune efficiency, owing to its requirement for the biological activity of many enzymes, protein and for cellular proliferation and genomic stability. (Mocchegiani, et. al., 2012).

Zinc is an essential trace element that functions as a cofactor for certain enzymes involved in metabolism and cell growth, As a component of many enzymes, Zn is involved in the metabolism of proteins, carbohydrates, lipids, and energy. Zn is vital for the healthy working of many of the body's systems; it plays an essential role in numerous biochemical pathways. It is particularly important for healthy skin and is essential for a healthy immune system and resistance to infection. (Soetan, 2010).

Zinc is necessary for normal growth and development in children, proper functioning of the immune system, many neurological functions and reproduction. Dietary zinc deficiency is quite common in the undeveloped world and may affect some two billion persons. It can cause impaired development, anemia, skin rashes, neurologic abnormalities and decreased immune function. (Franz Gliederer, et. al., 2017). Nuts and oils seeds, Sea foods, Poultry, Egg, Condiments and spices, Grains and legumes are the foods that are rich in zinc. (Falah, et al., 2017).

For Human, 0.005mg of Chromium is required per day (Prashanth, et al., 2017). Trivalent chromium is known to enhance insulin action and is necessary for optimal carbohydrate and lipid metabolism. It was observed that chromium supplementation reversed glucose intolerance in patients receiving parenteral nutrition. (Lipko and Debski, 2018).

Chromium is an essential element for animals and Soetan et al. 209 humans (Frieden, 1984). It has been found in nucleoproteins isolated from beef liver and also in RNA preparations (Uppala et al., 2005). It could play a role in maintaining the configuration of the RNA molecule, because Cr has been shown to be particularly

effective as a cross-linking agent for collagen (Eastmond et al., 2008). Cr has also been identified as the active ingredient of the glucose tolerant factor (Brown, 2003).

Chromium helps with insulin functions and glucose metabolism. Not getting enough chromium can lead to symptoms that mimic diabetes, impaired glucose tolerance and a need for higher insulin levels. Normally, a well-balanced diet that includes fruit, vegetables, meat, fish, and grains should easily cover dietary needs of chromium. (Gliederer, et al., 2017). Chromium rich food stuffs are Cereals and millets, Grain legumes, Fruits, Spices and condiment, Nuts and oil seeds, Milk products and Fishes. (Longvah, et al., 2017).

Needs for the study:

As the importance of trace elements are well known and its presence is essential for many functions in our body. The daily dietary intake of trace elements like Copper, Zinc and Chromium is not still analyzed in humans, but many number of animal studies are carried out to impart the importance of trace elements. So this study paves way to analyze the dietary consumption pattern and intake of trace elements.

Objectives:

1. To assess the dietary pattern and daily intake of Copper (Cu), Zinc (Zn) and Chromium (Cr), among the Adults.
2. To find out the food sources used commonly for the trace elements.
3. To calculate the mean intake of selected elements consumed by adults through various food sources.

CHAPTER 2

REVIEW OF LITERATURE

The review of literature pertaining to the study entitled “**DIETARY INTAKE OF TRACE MINERALS (COPPER, ZINC AND CHROMIUM) AMONG SELECTED ADULTS**” is discussed below:

- I. Overview of Trace minerals.
- II. Deficiency outcomes and Clinical studies on selected trace minerals.

I. Overview of Trace minerals status among adults

Global

The life-sustaining properties of trace minerals in foods consumed by humans and the associated possibilities for enhancing both functional and market value by changing methods of food production. Despite the fact that the role of trace minerals in animal and human health is well established, they are the great forgotten nutrients in animal diets. Their physiological role is often underestimated and their presence in the feed inadequate quantities is taken for granted.

However, they are necessary to maintain body function, to optimise growth and reproduction and to stimulate immune response and therefore determine the health status. Indeed, it is difficult to realize the impact of insufficient trace minerals, as symptoms of deficiency or mineral unbalances may not always be evident. However, a slight deficiency of trace minerals can cause a considerable reduction in performance and production. (Lopez-Alonso, 2012).

The importance of mineral elements in human, animal and plant nutrition has been well recognized (Underwood, 1971; Darby, 1976). The trace elements are essential components of enzyme systems. To assess the dietary intake and adequacy of minerals, information needs to be collected on mineral element content of foods, diets and water (Rao and Rao, 1981; Simsek and Aykut, 2007). The significance of the mineral elements in humans, animals and plants nutrition cannot be overemphasized. Mineral elements play important roles in health and disease states of humans and domestic animals.

For example, iron deficiency anaemia and goitre due to iodine deficiency are reported to be problems of public health importance in some communities (Partwardhan, 1961; Deosthale and Belavady, 1978).

Trace minerals have essential functions including; Being crucial building blocks for hundreds of enzymes. Facilitating a multitude of biochemical reactions, being a requirement for normal growth and development as well as neurological functions, Serving as anti-oxidants, Supporting the blood system, Being necessary for certain hormones, Being required for normal gonadal development. (Gliederer and Stephenson-Laws, 2017).

The regular intake of trace minerals supports the body in proper physiological function and can ward off health problems. Trace minerals are required for numerous body functions and processes including enzyme function, thyroid regulation, glucose absorption, blood clotting, tissue formation, the transportation of oxygen in red blood cells, detoxification and much more. A deficiency in any single trace mineral can result in an imbalance of other minerals and halt the benefits, making the body vulnerable. (Energetic Nutrition, 2015).

Trace minerals may further help to: Nourish hair and skin, enhance circulation, improve digestion and bowel function, Facilitate the transfer of nutrients across cell membranes, Regulate the body's maintenance and growth of cellular and muscle tissue, Balance the contraction and relaxation of muscle tissue, Provide both structural and functional support for the body's vital systems, Normalize pH levels and prevent an overly acidic state inside the body, Improve cellular communication, Liquify stagnant and toxic lymphatic fluid, Facilitate countless other metabolic processes important for maintaining life. (Bollinger, 2018).

Trace elements are very essential for the body to perform different functions and are very important for cell functions at biological, chemical and molecular levels. These elements mediate vital biochemical reactions by acting as cofactors for many enzymes, as well as act as centers for stabilizing structures of enzymes and proteins. The accumulation of metals or deficiency of these elements may stimulate an alternate pathway which might produce diseases. These elements account for only 0.02% of the total body weight, they play significant roles. (Prashanth, et. al., 2015).

A) Copper

Copper is the 26th element in abundance in the crust of the earth and is the 29th element in the periodic table with 2 stable and 9 radioactive isotopes. Copper deficiency is the leading deficiency worldwide among nutritional diseases of agricultural animals. (Collins and Klevay, 2011).

The failure to observe a relationship between copper exposure or status and negative health outcomes in most of these studies might suggest that Copper nutrition is not an issue in Western countries and that for most people, Copper intake meets nutritional requirements. Alternatively (i) uncertain-ties regarding Copper concentration in foods and water and (ii) the lack of biomarkers of Copper status make it impossible to simply rule out the risk of subject misclassification in term of Copper exposure and may confuse the link between Copper intake and health. (Bost, et al., 2016).

Cu is an essential micronutrient necessary for the hematologic and neurologic systems. It is necessary for the growth and formation of bone, formation of myelin sheaths in the nervous systems, helps in the incorporation of Fe in hemoglobin, assists in the absorption of Fe from the gastrointestinal tract, and in the transfer of Fe from tissues to the plasma. (Jeremias, et al., 2006).

Common daily intake of Copper is 1.35mg per day is required. (RDA, 2010). Depending on the source of the biological material, copper content ranges from parts per billion (ppb) to parts per million (ppm). Copper's essentiality was first discovered in 1928. Copper is found in much of the natural environment, including water, soils, and fugitive dusts. The amounts vary from location to location depending on specific conditions. (Stern, et al., 2007).

In order of increasing concentration on a weight basis, fats and oils, dairy products, sugar, tuna, and lettuce are low in copper (all, 0.4 mg/g); legumes, mushrooms, chocolate, nuts and seeds, and liver are high in copper (all .2.4 mg/g). Although not high in copper, bread, potatoes, and tomatoes are consumed. (Collins and Klevay, 2011).

Rich source of copper in foods are Grains and Legums, Condiments, Nuts and Oil seeds, Poultry and Fish. The best dietary sources of best to human body include wheat,

barley, sunflower seeds, almonds, pecans, walnuts, peanuts, cashews, prunes, raisins apricots, various dried beans, mushrooms, chicken, and most fish. (Al-Fartusie, and Mohssan, 2017)

Sources include liver, whole grains, molasses, legumes, nuts, shell fish and other seafoods. (Soetan, 2010).

B) Zinc

Zinc deficiency is ranked as the 5th leading risk factor in causing disease, especially diarrhea and pneumonia in children, which can lead to high mortality rates in these underdeveloped regions. Other severe deficiency symptoms include stunted growth and impaired development of infants, children, and adolescents. Early Zinc deficiency also leads to impaired cognitive function, impaired immune function, behavioral problems, memory impairment, and problems with spatial learning and neuronal atrophy. Public health programs involving Zinc supplementation and food fortification could help overcome these problems (Al-Fartusie, 2017).

The World Health Organization (WHO) advocates Zn supplementation for severe malnutrition and diarrhea. Zinc supplements help prevent disease and reduce mortality, especially among children with low birth weight or stunted growth (Soetan, 2010).

A large number of studies have elucidated the significant role of zinc as an intracellular signalling molecule playing very important role in cell-mediated immune functions and oxidative stress with very wide clinical ramifications. Concurrent zinc deficiency present in many chronic disorders needs correction to obviate complications and increased morbidity.

Mild to moderate zinc deficiency may be common in the developing countries but the public health importance of this degree of zinc deficiency is not well defined. It is therefore suggested that status of zinc should be assessed in relevant clinical situations. There are still avenues for further research particularly controlled clinical trials to establish the potential use of zinc as a preventive and therapeutic agent for a wide range of diseases in human. (Devi, 2014).

Zinc is distributed widely in plant and animal tissues and occurs in all living cells. It functions as a cofactor and is a constituent of many enzymes like lactate

dehydrogenase, alcohol dehydrogenase, glutamic dehydrogenase, alkaline phosphatase, carbonic anhydrase, carboxypeptidase, superoxide dismutase, retinene reductase, DNA and RNA polymerase. Zinc dependent enzymes are involved in macronutrient metabolism and cell replication (Hays and Swenson, 1985; Arinola, 2008).

Carbonic anhydrase is present in erythrocytes, kidney tubules, gastrointestinal mucosa and glandular epithelium. The primary roles of zinc appear to be in cell replication and gene expression and in nucleic acid and amino acid metabolism. Vitamins A and E metabolism and bioavailability are dependent on zinc status (Szabo et al., 1999).

The average amount of Zinc required is 12mg for males and 10mg per day for females. (RDA, 2010). 2 to 5mg of zinc per day is excreted through pancreas and intestine, others are excreted via proximal tubule and sweat gland. (Prashanth, et al., 2017.).

Zinc is found in wheat, brown rice, oats, lentils, soybeans, dried peas, black-eyed peas, lima beans, walnuts, peanuts, cashews, brazil nuts, many cheeses, any kind of liver, and animal flesh such as beef, lamb, chicken, turkey, and various fish and seafood. (Al-Fartusie, and Mohssan, 2017).

Sources include red meat, fish meals, liver, eggs, dairy products, vegetables and some sea foods. (Soetan, 2010).

C) Chromium

In 2001, Dietary Reference Intakes for chromium were established. Adequate intakes of chromium is 33 µg/day for adult males females. (RDA, 2010). Brief review of research results for chromium as an essential element shows that chromium is an important microelement essential for normal carbohydrate, lipid and protein metabolism. On the other hand, there are many unanswered questions concerning chromium supplementation and even a paper challenging the essentiality of chromium has recently been published (Stearns, 2000).

Results provide prospective human data showing that higher chromium levels in young adulthood are associated with lower incidence of MetS later in life. Specifically, chromium may have favorable effects on the lipid profile and the development of insulin resistance. Further studies are needed to establish causal inference and better understand the

potential mechanism of action. Studies that separately examine the association of trivalent and hexavalent chromium with risk of MetS are also warranted (Jianling, et al., 2015).

Chromium is an essential element for animals and humans (Frieden, 1984). It has been found in nucleoproteins isolated from beef liver and also in RNA preparations (Uppala et al., 2005). It could play a role in maintaining the configuration of the RNA molecule, because Cr has been shown to be particularly effective as a cross-linking agent for collagen (Eastmond et al., 2008). Cr has also been identified as the active ingredient of the glucose tolerant factor (Brown, 2003), a dietary factor required to maintain normal glucose tolerance in the rat. Trivalent chromium is a constituent of “glucose tolerance factor” (GTF), which binds to and activates/potentiates insulin action (Wennberg, 1994; Murray et al., 2000).

For Human, 0.005mg of Chromium is required per day, it is excreted in the urine and in the hair, sweat and bile as in small quantities. The major eliminating route of chromium after absorption is fecal. (Prashanth, et al., 2017).

Chromium is widely distributed in the food supply, but most foods provide only small amounts of it. It is found in egg yolks, whole-grain products, high-bran breakfast cereals, coffee, nuts, green beans, broccoli, meat, and brewer’s yeast. (Al-Fartusie, and Mohssan, 2017).

The Chromium content of foodstuffs varies widely and is present in combination with a small organic molecule, the glucose tolerant factor. Chromium poisoning in humans is usually limited to accidental ingestion of chromic acid or chromates. Toxicity to kidney, liver, nervous system and blood are the major causes of death (Langard, 1980). Sources include meat, liver, brewer’s yeast, whole grains, nuts, cheese (Soetan, 2010).

II. Deficiency outcomes of selected trace minerals

Deficiency as well as excess in either nutrient can produce a variety of biochemical and physiologic changes and has been implicated in the etiology of chronic disease. (WHO, 1996).

Micronutrient deficiencies are a major public health problem in many developing countries, with infants and pregnant women especially at risk (Batra and Seth, 2002).

Infants deserve extra concern because they need adequate micronutrients to maintain normal growth and development (Rush, 2000). The micronutrient deficiencies which are of greatest public health significance are iron deficiency, causing varying degrees of impairment in cognitive performance, lowered work capacity, lowered immunity to infections, pregnancy complications e.g. babies with low birth weight, poor learning capacity and reduced psychomotor skills (Batra and Seth, 2002).

Medical reports show that very severe anaemia is a direct cause of maternal and child mortality (Chakravarty and Ghosh, 2000). There have been suggestions that more than anything else, lack of adequate information about the composition of varied feed resources in some regions have been the major drawback to their utilization, rather than real shortage (Aletor and Omodara, 1994).

A) Copper

Copper deficiency has been described in infants on total parenteral nutrition without adequate mineral supplementation and in malabsorption syndromes or persistent nephrotic syndrome that increase copper losses. Low copper status has been associated with bone malformation during development, risk of developing osteoporosis in later life, impaired melanin synthesis, poor immune response and increase frequency of infections, poor cardiovascular health, alterations in cholesterol metabolism. Disturbance of the metabolism of other trace elements, such as iron mobilization, may lead to secondary iron deficiency and anemia. (Romana, et al., 2011).

Clinical disorders associated with Copper deficiencies include anaemia, bone disorders, neonatal ataxia, depigmentation and abnormal growth of hair, fur or wool, impaired growth and reproductive performance, heart failure and gastrointestinal disturbances. The incidence of these disorders varies widely among animal species. Copper deficiency has also been associated with cardiac hypertrophy and sudden cardiac failure. Gardea-Torresdey et al. (1990) reported that carboxyl groups found on the cell walls of dead algal biomass are potentially responsible for copper binding. Toxicity disease or symptoms are rare and is secondary to Wilson's disease (Murray et al., 2000).

In Wilson's disease, a large amount of copper is deposited in liver, brain, etc. Total copper content in the plasma and ceruloplasmin-bound copper content decreases

and there is an increased excretion of copper in the urine. Sometimes, Copper may be deposited in the renal tubules giving rise to renal tubular degeneration and this is manifested as glycosuria and amino aciduria (Malhotra, 1998). Excess dietary Copper causes an accumulation of Copper in the liver with a decrease in blood haemoglobin concentration and packed cell volume. (Soetan, 2010).

Copper is a constituent of enzymes like cytochrome oxidase, amine oxidase, catalase, peroxidase, ascorbic acid oxidase, cytochrome oxidase, plasma monoamine oxidase, erythrocytin (ceruloplasmin), lactase, uricase, tyrosinase, cytosolic superoxide dismutase etc. and it plays a role in iron absorption (Chandra, 1990).

Cu is an essential micro-nutrient necessary for the haematologic and neurologic systems (Tan et al., 2006). It is necessary for the growth and formation of bone, formation of myelin sheaths in the nervous systems, helps in the incorporation of iron in hemoglobin, assists in the absorption of iron from the gastrointestinal tract (GIT) and in the transfer of iron from tissues to the plasma (Malhotra, 1998; Murray et al., 2000). It is transported by albumin; bound to ceruloplasmin.

Ceruloplasmin has oxidase activity and thereby facilitates the incorporation of ferric iron into transferrin. The copper-containing protein in red blood cells (rbc) is erythrocytin, in liver, it is hepatocytin and in brain, it is cerebrocytin. In the monogastric animals, copper is absorbed mainly in the upper part of the small intestine, where the pH of the contents is still acidic. In general, Cu is poorly absorbed, and under normal conditions >90% of the ingested copper appears in the faeces. Most of the faecal copper is unabsorbed dietary copper, but some of it comes from the bile, which is the major pathway of Cu excretion. Biliary obstruction increases the excretion of copper through the kidney and intestinal wall (Hays and Swenson, 1985).

Copper absorption is also inversely related to copper intake or status and this may account for much of the intra experimental variability in studies of copper absorption; values ranging from 25% to 60% efficiency of absorption of administered copper have been common. Copper intakes ranging from 1.4 mg/day to 3.3 mg/day for which the respective absorptive efficiencies were between 41% and 26%, and absolute absorption

of copper ranged from 0.59 to 0.84 mg/day. However, quantitative data on such relationships are insufficient, as yet, for it to be possible to allow for their effect when estimating copper requirements. (WHO, 1996).

50% of copper is absorbed from the gastrointestinal tract (GIT) and rest is excreted through bile and kidney. (Prashanth, et. al., 2017.). Copper released from intestinal cells moves to the serosal capillaries, where it binds to albumin, glutathione, and amino acids in the portal blood (Marceau et al., 1970; Bligh et al., 1992).

Copper from portal circulation is primarily taken up by the liver. Once in the liver, copper is either incorporated into copper-requiring proteins, which are subsequently secreted into the blood, transported to extra-hepatic tissues by albumin, amino acids, or mostly (estimates vary from 70– 80%) by ceruloplasmin, or excreted into the bile (Ralph & McArdle, 2001).

Regulating copper release, the liver exerts homeostatic control over extra hepatic copper (Harris, 2000). Ceruloplasmin is a serum ferroxidase that contains greater than 95% of the copper found in plasma. The protein is a sialoglycosylated oxidase containing seven copper atoms. Ceruloplasmin functions in the release of iron from cells with mobilizable iron stores. In aceruloplasminemia, copper homeostasis is normal (Gitlin, 1998). Specific cell membrane receptors for ceruloplasmin have been identified in heart, brain, liver, kidney, and lymphocytes (Linder and Hazegh Azam, 1996).

Liver endothelial cells can remove sialic acid residues from ceruloplasmin. The hepatocytes that lie under the endothelium are then capable of absorbing the deglycosylated ceruloplasmin via a receptor and subsequently digesting the protein. While cells can apparently acquire copper by this route, it represents only an accessory mechanism (Hellman & Gitlin, 2002).

Copper conservation in the liver occurred only after 55–65% of total liver copper content was lost, at which point no further copper was exported to the plasma; serum ceruloplasmin activity also decreased at this point. Skeletal muscle does not appear to conserve copper significantly, and it is thought (Ralph & Ardle, 2001).

Bile is the major pathway for the excretion of copper and is vitally important in the control of liver copper levels (Cousins, 1985; Winge & Mehra, 1990; Turnlund, 1998). After the oral administration of radioactive copper as copper acetate in healthy humans, 72% was excreted in the feces (Bush et al., 1955).

Copper in bile is associated with low-molecular-weight copper-binding components as well as macromolecular binding species (Gollan & Deller, 1973), resorption of biliary copper is negligible (Farrer & Mistilis, 1967).

Most fecal copper results from biliary excretion; the remainder is derived from unabsorbed copper and copper from desquamated mucosal cells. Biliary excretion of copper following administration does not increase proportionally with dosage, suggesting that the hepatobiliary transport of copper is saturable (Gregus & Klaassen, 1986).

Copper is toxic at high levels. An overload of this metal easily leads to Fenton-type redox reactions, resulting in oxidative cell damage and cell death. However, Copper toxicity as a result of dietary excess is generally not considered a widespread health concern, probably as a result of the homeostatic mechanisms controlling Copper absorption and excretion (Turnlund, et al., 2005).

B) Zinc:

Zinc deficiency was reported that nearly two billion people in the developing world are deficient in zinc. Zinc deficiency is a serious problem in many developing countries. (Al-Fartusie, and Mohssan, 2017).

In humans, deficiency disease or symptoms include hypogonadism, growth failure, impaired wound healing, decreased taste and smell acuity, secondary to acrodermatitis enteropathica, parenteral nutrition (Murray et al., 2000).

The biochemical lesions causing this syndrome in the osteogenic processes are probably due partly from a reduction in the activity of alkaline phosphatase which is a zinc enzyme (Gordon, 1977). Toxicity disease or symptoms of zinc in humans include gastrointestinal irritation, vomiting, decreased immune function and a reduction in high density lipoprotein (HDL) cholesterol. Higher dietary levels of Zinc are required in the presence of phytic acid to prevent parakeratosis and allow for normal growth (Sidhu et al., 2004).

The oxide, carbonate, and sulfate forms of zinc are efficiently utilized, whereas the sulfide form is poorly utilized. Zinc, either ingested or injected, is primarily excreted in the faeces. The Zinc found in the faeces consist mainly of unabsorbed dietary Zinc, and the balance is from pancreatic excretions. Urinary excretion of Zinc and several other metals are increased if chelating agents such as ethylenediaminetetraacetic acid (EDTA) are administered in combination with zinc (Hays and Swenson, 1985).

The efficiency of zinc absorption is related inversely to both the current intake of zinc and the existing zinc status. It was shown by the use of vascular perfused intestinal preparations that the efficiency of zinc absorption and transfer to the vascular system previously depleted of zinc was approximately twice that of over a wide range of intakes. Uptake and retention of orally administered zinc can range between 95% and 5% of intake depending on preexisting zinc status. Studying stable isotope zinc metabolism in a subject previously given 7, 15 and 30 mg of zinc/day, found that zinc absorption was 47, 32 and 21% respectively. (WHO, 1996).

Zinc is required for catalytic activity of more than 200 enzymes and it plays a role in immune function, wound healing, protein and DNA synthesis, and cell division. Also required for proper sense of smell and taste, supports normal growth and development during pregnancy, childhood and adolescence. Act as an anti-oxidant. (Osredkar and Sustar, 2011).

Zinc is absorbed into the body through the small intestine, which also regulates whole-body homeostasis through changes in both the fractional absorption of dietary zinc and excretion of endogenous zinc in pancreatic juice and other gastrointestinal secretions (Jackson, 1989; King, et al., 2000.).

Some zinc is also lost from the body through urine, menstrual flow, semen, and sloughed skin, nails, and hair, although quantitatively these other routes of zinc loss are relatively small compared with gastrointestinal excretion (King, et al., 2000).

As with intestinal excretion, the urinary elimination of zinc can be affected by zinc status (Baer, et. al., 1984), although this effect is less consistent and may only occur with more severe or prolonged dietary restriction. Fecal zinc excretion is also increased during diarrhea (Castillo-Duran, et al., 1988).

Approximately 90% of the body's zinc reserves turn over slowly and are therefore not readily available for metabolism. The remaining zinc comprises the so-called rapidly exchangeable pool of zinc, which is thought to be particularly important for maintaining zinc-dependent functions of human biological systems. The rapidly exchangeable zinc can move into and out of the plasma compartment within a period of about three days. The size of this pool is sensitive to the amounts of zinc absorbed from the diet, and a reasonably constant dietary supply is thought to be necessary to satisfy the normal requirements of zinc for maintenance and growth (Kenneth, 2011).

Less than 0.2% of the total body zinc content circulates in plasma, which has a mean concentration of approximately 15 $\mu\text{mol/L}$ (about 100 $\mu\text{g/dl}$). Zinc is transported in plasma bound to albumin and, to a lesser extent, α_2 -macroglobulin and oligopeptides. (Cousins, et al., 1996.). An amount of zinc equivalent to the total absorbed zinc is re-excreted into the gut in intestinal fluids. In normal health zinc output by the gut is equal to the total dietary intake.

Urinary excretion of zinc is low and does not vary markedly with dietary supply. It is increased in catabolic states, by certain drugs and/or chelating agents. Galvanized cages and troughs provide poultry with appreciable amounts of zinc and to a certain extent, this have been responsible for the infrequent occurrence of zinc deficiency in the field (Gordon, 1977).

It is present in meat and other protein foodstuffs, but intestinal absorption is affected by other dietary constituents. Absorbed zinc enters the liver where it is incorporated into zinc metalloenzymes and exported to peripheral tissue in plasma, bound to albumin.

A large percentage, about 90%, of the total plasma zinc concentration is associated with albumin, <10% with alpha-2 macroglobulin, and a small amount, <1%, complexed to amino acids and other low molecular weight species. A high dietary iron intake can decrease zinc absorption. Zinc homeostasis is achieved by regulation of enterohepatic re-circulation. However, with the increasing use of plastics instead of galvanized steel, it is now important to ensure that poultry diets contain adequate amounts of this element and some are now supplemented with zinc oxide or carbonate (Soetan, 2010).

C) Chromium:

Chromium deficiency lead to Impaired glucose tolerance, Increased circulating insulin, Elevated cholesterol and Elevated triacylglycerol. (Lukaski, 2000.).

Some studies reported that chromium deficiency is associated with glucose intolerance and insulin resistance in patients on long-term parenteral nutrition, it has been reported that chromium deficiency may be the reason to an increase in hematological parameters like hemoglobin, hematocrit, erythrocytes, leukocytes, and mean erythrocyte volume (Al-Fartusie, 2017).

Chromium deficiency leads to a reduced rate of removal of ingested glucose, due to a low sensitivity of peripheral tissues to insulin. Chromium is needed for growth of rats and its deficiency leads to a reduced life span, corneal lesions and interference with insulin action producing a diabetic state and this causes removal of glucose from the blood at a rate that is onehalf that of animals on a chromium-containing diet (Wennberg, 1994; Juturu and Komorowski, 2003).

Evidence of a role for chromium in lipid metabolism and chromium deficiency in the development of atherosclerosis is accumulating from animal and human studies (Frieden, 1984). Chromium deficiencies may exist, particularly in children suffering from protein-calorie malnutrition (Mertz, 1974).

Chromium absorptive efficiency is also inversely related to previous dietary intake of chromium. That 0.5% of a dose of 40 μ g of chromium was absorbed by subjects receiving 40 μ g/day as compared with 2% when intake was 10 μ g of chromium/day. Intakes of chromium of 40 μ g/day, efficiency of absorption remained virtually constant at 0.4%, homoeostasis being achieved by increased urinary output. (WHO, 1996).

Chromium is a chemical element with symbol Cr and atomic number 24. It is a steely-gray, lustrous, hard, and brittle metal. Chromium is a trace element that humans require in trace amounts. It is found primarily in two forms: Trivalent (chromium III), which is biologically active and found in food and hexavalent (chromium VI), a toxic form that results from industrial pollution. (Al-Fartusie, and Mohssan, 2017).

Absorption of chromium from the gut and its urinary excretion are significantly higher in insulin-requiring diabetes than in healthy subjects. Chromium maintains normal glucose tolerance primarily by regulating insulin action. In the presence of chromium, much lower amounts of insulin are required. (ANDERSON, 1989.).

Chromium was found to decrease the insulin resistance problems seen in individuals who smoke cigarettes. Chromium is an antioxidant, which helps protect the body against free radical damage. Chromium has demonstrated the ability to low density lipoprotein (LDL or bad) cholesterol levels and raise high density lipoprotein (HDL or good) cholesterol levels in the blood, particularly in people having with high cholesterol. (Tulasi and Jayantha Rao, 2014.).

Chromium is present in the diet both as the inorganic form and organic complexes. The rate of absorption of inorganic Cr is low, from 0.4-3%, and is a function of daily dose supplied. The concentration of Cr in the lungs, aorta, heart and spleen decreases during the first months of life, whereas the liver and kidneys maintain their neonatal level up to the age of 10 years. The biological function of chromium is not fully known yet. It is postulated that chromium interacts with the thyroid metabolism in humans. Binding of Cr (III) with nucleic acids has been found to stimulate the DNA-dependant RNA synthesis. (MERTZ, 1992.).

Chromium levels in biological matter have been studied extensively. It has been found that chromium produces significant increases in enzyme activity and serves an important function in carbohydrate metabolism, stimulation of fatty acid and cholesterol synthesis from acetate in the liver, and improved sugar metabolism through the activation of insulin. In addition, it has been found that chromium renders the body's tissues more sensitive to insulin. It is a critical cofactor in the action of insulin. In fact, the actual chromium deficiency in humans is rare. (Al-Fartusie, and Mohssan, 2017).

Chromium affects the action of insulin in protein metabolism, as indicated by rats fed chromium-deficient diets repleted by chromium (Roginski and Mertz, 1969). Insulin-mediated amino acid transport into tissues was enhanced and incorporation of labeled glycine, serine and methionine into heart protein was greater in chromium-supplemented animals. (Frieden, 1984).

CHAPTER 3

METHODOLOGY

The methodology for the study entitled '**Dietary Intake of Trace Minerals (Copper, Zinc, Chromium) among Selected Adults**' is discussed under the following headings:

A. Selection of area and identification of subjects

B. Study on the background

C. Assessment of anthropometry

D. Assess the Dietary Intake of selected adults

Ethical Clearance for the study was obtained from Institutional Human Ethics Committee (IHEC), Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore with approval no. AUW/IHEC/FSMD-17-18/XPD/05 (Appendix I).

A. Selection of area and identification of subjects

The area selected for the study is Coimbatore City. Coimbatore is one of the fastest growing tier-II cities in India and a major industrial hub in South India. The target group adults were selected for study from urban areas like Saibaba Colony and Ramalingam Colony. A total of 285 families were selected based on convenient sampling and from those families 200 adults were selected by purposive sampling method for the study.

A total of 200 adults both males (100) and females (100) from the selected locality belonging to the age group of 19-29 years were selected for the study by purposive sampling. The purposive sampling technique, in technique where in the researcher decides what needs to be known and set out to find people who can and are willing to provide the information by virtue of knowledge or experience (Bernard, 2002). A consent form was prepared by the investigator and got signature from all the subjects participated in this study (Appendix II).

The following inclusion and exclusion criteria were followed for the selection of the adults.

Inclusion criteria:

- Both genders
- Adults in the age group of nineteen to twenty-nine years
- Willingness to participate in the study
- Only one member from a family

Exclusion criteria:

- Adults above the age of twenty-nine years
- Adults below the age of nineteen years
- Pregnant and lactating mothers
- Adults taking supplements

B. Study on the background details

Background information was collected from the subjects (200) through direct and face to face interview with the subjects using an interview schedule (Appendix III). The details included were education occupational status, size of the family and income. The interview schedule was administered to the adults and the required information was collected.

An interview schedule is a method of collecting data where the questionnaire are asked and filled in by the interviewer with a face to face contact with the samples from whom the information are elicited (Gupta, 2004)

C. Assessment of Anthropometry

The most common anthropometry is height and weight and was assessed for all the adults using standard procedures.

Height

Height is a major component of body size. A non-stretchable measuring tape was used to measure the height of the subject and was recorded in centimetres. The adults were allowed to stand against the wall, bare foot and with heels; buttock, shoulder back

and back of the head touching the walls with toes apart and the height was measured to the accuracy of 0.1 cm.

Weight

Body weight is the most widely used simplest method to assess the growth and development of an individual (NIN, 2009)

Weight of the adults were recorded using bathroom scale, the subjects were asked to stand on the scale bare foot without shoes, minimum clothing and no holding support or touching nor leaning against the wall. The weight was measured to the accuracy of 0.1 kg of weight.



Plate I – Measuring weight of the Adults

Body Mass Index

Body Mass Index (BMI) is defined as the individual body weight in kilogram divided by the height in meter square and it was calculated based on the following formula.

$$\text{BMI} = \text{weight in kg} / \text{height in m}^2$$

The calculated BMI value was compared with the WHO, 2006 Standards and was categorized according to the Table I.

Table I
Category of Body Mass Index

Category	Range
Underweight	<18.50
Normal	18.50-24.99
Overweight	≥ 25.00
Obese	≥ 30.00

WHO, 2006

Waist Circumference

The WHO protocol for measuring waist circumference instructs that the measurement made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest. The measuring tape should not be stretched or expanded.

The subjects were asked to stand straight with their arms at the sides, feet positioned together and weight should be equally balanced. The waist circumference was measured through the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest by using non-stretchable measuring tape.



Plate II – Measuring waist circumference of the Adults

Hip Circumference

The Hip Circumference measurement should be taken around the widest portion of the buttocks. The measuring tape should not be stretch or expanded.

The subjects were asked to stand straight with arms at the sides, feet positioned together and weight should be equally balanced. The Hip circumference was measured around the widest portion of the two sides of buttocks by using non-stretchable measuring tape.

Waist Hip Ratio

WHR (Waist – Hip Ratio) was calculated with the measurement of Waist and Hip Circumference measured by above explained procedures. By using the formula and compared with WHO 2011 standards.

$$\mathbf{WHR = Waist Circumference (cms) / Hip Circumference (cms).}$$

Table II
Category of Waist Hip Ratio

	MALE	FEMALE
Waist Hip Ratio	Low Risk 0.9	Low Risk 0.85
	Moderate Risk 0.9 – 0.95	Moderate Risk 0.85 – 0.9
	High Risk > 0.1	High Risk > 0.9

SOURCE: WHO 2011

D. Assess the Dietary Intake of selected adults

The disease pattern of the subjects, that enquired which included their family history and medical status were assessed.

The dietary intake of adults was assessed using 24 hour dietary recall method for three consecutive days.

A 24 hour recall survey was conducted for 200 subjects both males and females in order to know the mean food and nutrient intake. Twenty four hour recall method is a quantitative method used in nutritional assessment. This method is followed to document food and beverages and nutrient intake of the subject (Ferrari et al., 2002) (Appendix IV).

Food consumption pattern

Food consumption pattern of trace elements was elicited by interview schedule (Appendix V). The questions asked to the adults were the frequency of food sources contributing to trace elements intake.

The mean dietary intake and the RDA (Recommended Dietary Allowance) was compared and analyzed. All the collected data was tabulated and recorded for males and females separately.

CHAPTER 4

RESULTS AND DISCUSSION

The Results and Discussion pertaining to the study “**Dietary Intake of Trace Minerals (Copper, Zinc and Chromium) among Selected Adults**” are discussed under the following headings:

A. Background details of the subjects

B. Anthropometric Details

C. Details on the intake of trace minerals

A. Background details of the selected subjects

The Back ground details of the 200 selected subjects samples is given below.

Table I

Age and Gender Distribution of the Adults

AGE (years)	MALE	FEMALE
	N = 100	N = 100
19 – 22	30	56
23 - 26	42	31
27 - 29	28	13

Table I shows that 30 males and 56 females were in the age group of 19 – 22 years, followed by 42 males and 31 females in the age group of 23 – 26 years.

The Education details of the 200 selected subjects is given below.

Table II
Education

CATEGORIES	MALE N= 100	FEMALE N = 100
Secondary	7	8
Higher Secondary	3	5
Diploma	2	Nil
UG Graduate	58	57
PG Graduate	27	25
M.Phil	3	5

The educational qualification of the selected adults shows that were all the adults were literate. Fifty eight males and 57 Females were graduates and 27 and 25 males and females respectively were postgraduate.

The Occupation details of the 200 selected subjects samples is given below.

Table III
Occupation

Occupations	Male	Female
Students	38	37
Working	22	9
Teacher	3	7
Engineer	18	4
Self Employed	19	27
Home maker	Nil	16

The occupation of the selected adults showed that the majority of males (38) and females (37) were students. The various other occupations among males and females were teachers (3 and 7 respectively), engineers (18 and 4 respectively) and self employed (19 and 24 respectively). While considering females, 16 of them were home makers.

The monthly income of the family is given below.

Table IV
Income of the Family

FAMILY INCOME	Amount Range	MALE	FEMALE
		N = 100	N = 100
Economically Weaker Section	≤ 5000	38	37
Low Income Group	Rs. 5001 to 10000	22	25
High Income Group	≥ 10000	40	38

Source: HUDCO 2010

The table shows the monthly income of the family. It was found that 40 males and 38 females belong to high income group; whereas 22 males and 25 females belong to low income group. The result also showed that 75 (males and females) comes under economically weaker group.

The family details of the selected subject samples is given below.

Table V
Details of the Family

TYPE	FAMILY	MALE	FEMALE
		N = 100	N = 100
	Nuclear	84	74
	Joint	16	26
SIZE	2 to 4	82	71
	4 to 7	18	29

The results showed that 82 males and 71 females had upto 2 to 4 members, whereas 18 males and 29 females had 4 to 7 members in family. The above table signifies that majority of the adult's family was nuclear.

B. Anthropometric Measurement

The Anthropometric details of the 200 selected subjects samples is given below.

Table VI

BMI of the selected Adults

BMI	RANGE	MALE	FEMALE
		N=100	N=100
Under Weight	<18.50	7	21
Normal (18.5 – 25)	18.50 – 24.99	43	41
Obese	≥30.00	50	38

Source: WHO, 2006

The result shows that 7males and 21 females were under weight. Obesity was seen higher in adults in which males (50) were more obese in number than females (38) This indicates that adults were easily prone to other complications due to obesity.

The Waist Hip Ratio of the selected males and females is given below.

TABLE VII

Waist Hip Ratio of the Adults

	Risk Category		
	Low	Moderate	High
Range	0.9	0.9 – 0.95	> 0.1
Males N = 100	32	54	14
Range	0.85	0.85 – 0.9	> 0.9
Females N = 100	8	21	71

SOURCE: WHO 2011

The table shows the WHR (Waist & Hip Ratio) of Males and Females. It was evident from the results that 71 females were in high risk and14 males were in this risk category.

C. Dietary Pattern

The Dietary pattern details of the 200 selected subject samples is given below.

Table VIII

Food Pattern

Particulars	MALE	FEMALE
	N = 100	N = 100
Vegetarian	14	16
Non-Vegetarian	86	84

From the results, it was observed that majority of males and females (86 and 84 respectively) were non-vegetarians.

Mean Intake of Macro and Trace Nutrients (Males and Females)

The mean Macro and Trace nutrient intake details of the 200 selected subjects is given below.

Table IX

Mean Macro Nutrient Intake of Males (N=100)

Nutrients	Mean intake	RDA Value	Deficient / Excess
Energy (kcal)	1384.43 ± 15.58	2320	-935.57
Protein (g)	64.58 ± 0.27	60	+4.58
Fat (g)	27 ± 0.98	25	+2
CHO (g)	208.69 ± 2.96	*	*

*Carbohydrate values are not given by RDA 2010.

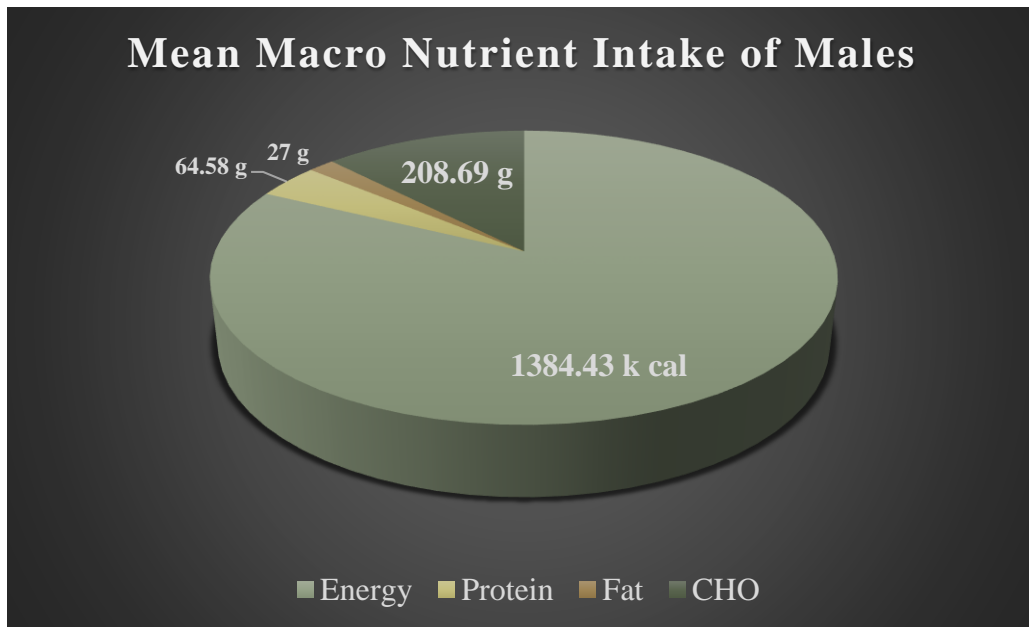


Figure 1: Mean Macro Nutrient intake of Males

The mean nutrient intake of males were calculated and compared with RDA 2010. It was found that the Energy (1384.43 ± 15.58 kcal) consumption was lower than the recommended dietary allowance. The Protein (64.58 ± 0.27 g) and Fat (27 ± 0.98 g) intake was observed to be sufficient. (Figure 1).

Table X

Mean Macro Nutrient Intake of Females (N=100)

Nutrient	Mean Value	RDA value	Deficient / Excess
Energy (kcal)	1374.50 ± 9.21	1900	-525.5
Protein (g)	65.99 ± 2.23	55	+10.99
Fat (g)	28.09 ± 3.12	20	+8.09
CHO (g)	207.19 ± 3.22	*	*

*Carbohydrate values are not given by RDA 2010.

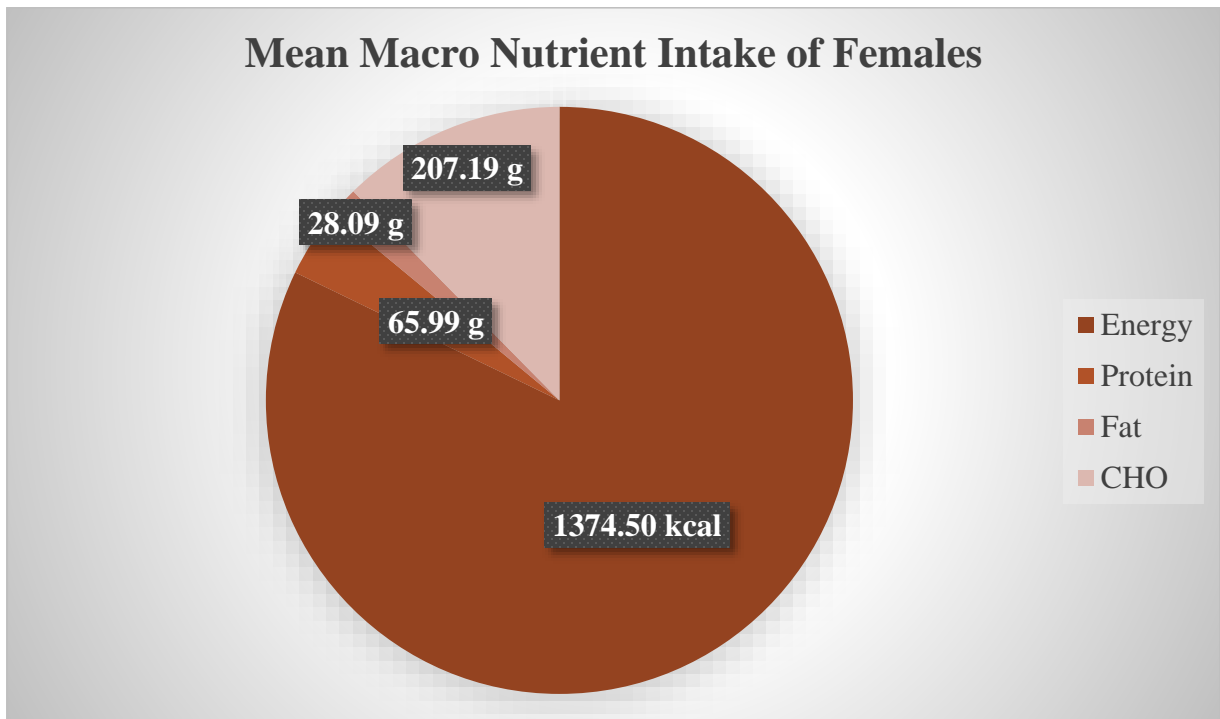


Figure 2: Mean Macro Nutrient intake of Females

While considering the females mean dietary intake it was observed that Energy (1374.50 ± 9.21 kcal) intake was found lowered. Meanwhile, The protein (65.99 ± 2.23 g) and fat (28.09 ± 3.12 g) intake was found to be sufficient. (Figure 2).

Table XI

Mean Trace Minerals Intake of Males (N=100)

Nutrient	Mean Value	RDA value
Copper (mg)	2.16 ± 0.07	1.35
Zinc (mg)	9.26 ± 0.07	12
Chromium (µg)	48 ± 1	33

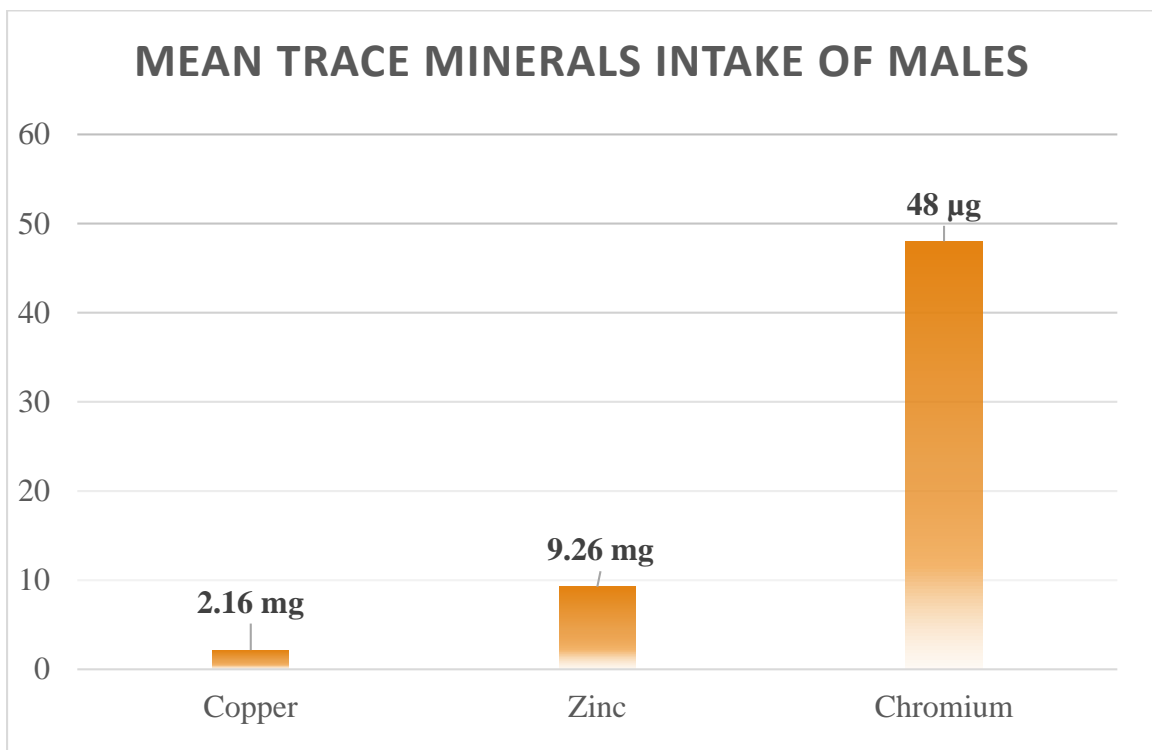


Figure 3 Mean Trace minerals intake of males

While measuring the mean nutrient intake of trace elements it was found that the intake of copper, zinc and chromium was 2.16, 9.26 and 48 µg respectively in males.

Table XII

Mean Trace Minerals Intake of Females (N=100)

Nutrient	Mean Value	RDA value
Copper (mg)	2.23 ± 0.71	1.35
Zinc (mg)	9.34 ± 0.46	10
Chromium (µg)	47 ± 2	33

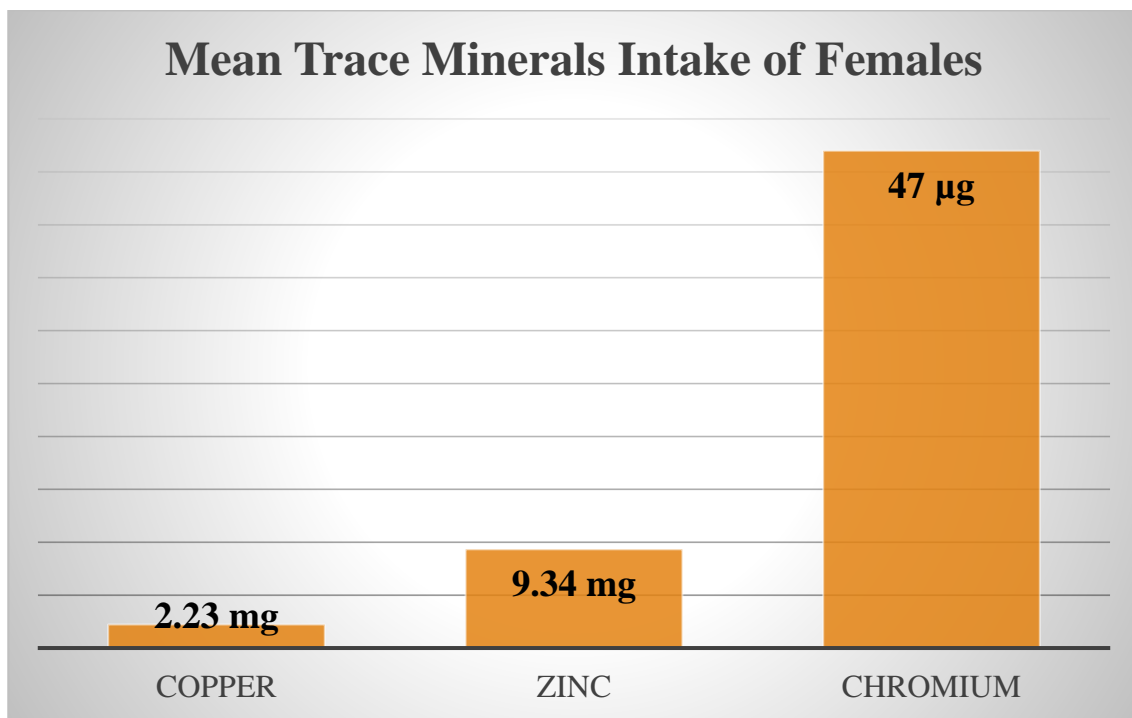


Figure 4 Mean Trace minerals intake of Females

While measuring the mean nutrient intake of trace elements it was found that the intake of copper, zinc and chromium was 2.23, 9.34 and 47 µg respectively in females.

Consumption of foods rich in Copper (Males and Females)

The consumption of Copper Zinc and Chromium nutrient intake details of the 200 selected subjects is given below.

Table XIII

Consumption of foods rich in Copper (Males)

Copper Rich Foods	Content (mg)	Daily	Weekly	Monthly	Never
Horse gram Whole	1.29	Nil	42	47	11
Red gram Dhal	1.14	4	63	27	6
Soya Bean	1.29	Nil	18	24	58
Corriander Seeds	1.46	3	60	21	16
Poppy	2.05	Nil	19	17	64
Almond	1.08	16	36	30	18
Cashewnut	2.23	13	43	28	16
Gingelly seed	1.64	4	45	17	34
Goat Liver	3.70	0	32	25	43
Crab	1.23	0	5	24	71

While considering the consumption of food sources of copper among males, reported that their daily consumption is limited to red gram dhal (4), almonds (16), cashew nut (13), gingelly seed (4) and coriander seeds (3). Majority of males consumed the above food sources weekly or monthly. Foods like goat liver (43) and crab (71) were not consumed by majority of males. Poppy seeds (64) and soya bean (58) was also never consumed by most of males.

Table XIV**Consumption of foods rich in Copper (Females)**

Copper Rich Foods	Content (mg)	Daily	Weekly	Monthly	Never
Horse gram Whole	1.29	Nil	32	51	17
Red gram Dhal	1.14	10	56	21	13
Soya Bean	1.29	Nil	18	34	48
Corriander Seeds	1.46	10	36	42	12
Poppy	2.05	Nil	24	35	41
Almond	1.08	10	32	38	20
Cashewnut	2.23	7	33	47	13
Gingelly seed	1.64	4	29	35	32
Goat Liver	3.70	Nil	19	27	54
Crab	1.23	Nil	8	21	71

While considering the consumption of food sources of females, they consumed foods like almonds (10), coriander seeds (10) and red gram dhal (10). Foods like poppy seeds (41), goat liver (54), crab (71) and soya bean (48) was not commonly consumed among females.

Consumption of foods rich in Zinc (Males and Females)

Table XV

Consumption of foods rich in Zinc (Males)*

Zinc Rich Foods	Content (mg)	Daily	Weekly	Monthly	Never
Bajra	2.76	Nil	5	38	57
Ragi	2.53	Nil	13	36	51
Wheat Flour	2.85	4	64	26	6
Soybean	3.74	Nil	18	24	58
Horse gram Whole	3.61	Nil	42	47	11
Poppy seeds	6.38	Nil	19	17	64
Corriander seeds	3.9	3	60	21	16
Cashewnut	5.34	13	43	28	16
Almond	3.50	16	36	30	18
Gingelly seed	8.07	4	45	17	34
Panner	2.74	Nil	10	51	39
Khoa	2.34	Nil	1	16	83
Chicken	2.0	Nil	54	24	22
Country Chicken	2.17	Nil	37	24	39
Goat	2.41	Nil	50	27	23
Crab	2.49	Nil	5	24	71

***Multiple Response**

It was surprising that millets like bajra and ragi were not consumed by males (57 and 51 males respectively). Zinc food sources were consumed in moderation by the selected males. The above table signifies the consumption of food sources of zinc in which the results showed that there majority of males never consume zinc food sources.

Table XVI**Consumption of foods rich in Zinc (Females)**

Zinc Rich Foods	Content (mg)	Daily	Weekly	Monthly	Never
Bajra	2.76	Nil	7	40	52
Ragi	2.53	Nil	18	46	36
Wheat Flour	2.85	8	60	25	7
Soybean	3.74	Nil	18	34	48
Horse gram Whole	3.61	Nil	32	51	17
Poppy seeds	6.38	Nil	24	35	41
Corriander seeds	3.9	10	36	42	12
Cashewnut	5.34	7	33	47	13
Almond	3.50	10	32	38	20
Gingelly seed	8.07	4	29	35	32
Panner	2.74	Nil	8	54	38
Khoa	2.34	Nil	8	14	78
Chicken	2.0	Nil	50	24	26
Country Chicken	2.17	Nil	25	41	34
Goat	2.41	Nil	44	20	36
Crab	2.49	Nil	8	21	71
Fish	1.69	Nil	Nil	5	95

Among females, crab and fish were never consumed (71 and 95 respectively). Wheat flour, cashew nut and almonds were consumed daily by limited females. This signifies that the zinc food sources was not well known among the females.

Consumption of foods rich in Chromium (Males and Females)

Table XVII

Consumption of foods rich in Chromium (Males)

Chromium Rich Foods	Content	Daily	Weekly	Monthly	Never
Bajra	2.76	Nil	5	38	57
Horse gram Whole	3.61	Nil	42	47	11
Amaranth leaves	0.028	Nil	24	40	36
Gogu Leaves	0.051	Nil	28	40	32
Capsicum	0.039	Nil	20	22	58
Onion Stalk	0.059	Nil	24	29	46
Poppy Seeds	0.030	Nil	19	17	64
Corriander seeds	0.041	3	60	21	16
Gingelly seeds	0.029	13	43	28	16
Mushroom	0.058	4	45	17	34
Paneer	0.110	Nil	10	51	39
Khoa	0.119	Nil	1	16	83
Fish	0.045	Nil	Nil	4	96

The food sources of chromium was listed above, it was evident that the chromium sources was mainly from gingelly seeds, mushrooms and coriander seeds. majority of the sources were not consumed regularly among males.

Table XVIII**Consumption of foods rich in Chromium (Females)**

Chromium Rich Foods	Content (mg)	Daily	Weekly	Monthly	Never
Bajra	2.76	Nil	7	40	52
Horse gram Whole	3.61	Nil	42	47	11
Amaranth leaves	0.028	Nil	24	50	26
Gogu Leaves	0.051	Nil	27	29	44
Capsicum	0.039	Nil	21	39	40
Onion Stalk	0.059	Nil	25	51	24
Poppy Seeds	0.030	Nil	24	35	41
Corriander seeds	0.041	10	36	42	12
Gingelly seeds	0.029	4	29	35	32
Mushroom	0.058	Nil	10	37	53
Paneer	0.110	Nil	8	54	38
Khoa	0.119	Nil	8	14	78
Fish	0.045	Nil	Nil	5	95

While considering females, sources like coriander and gingelly seeds were commonly used. Other sources were either rarely consumed or never consumed at all. This shows that chromium food sources were limited among females.

CHAPTER 5

SUMMARY AND CONCLUSION

The summary pertaining to the subject **“Dietary intake of Trace Minerals (Copper, Zinc and Chromium) among Selected Adults”**.

Essential trace elements play an important role as a cofactor for certain enzymes involved in metabolism and cell growth, most of them involved in the metabolism of proteins, carbohydrates, lipids, and energy. They are also necessary for growth, development, muscle and nerve function, normal cellular functioning, and synthesis of some hormones and connective tissue.

Despite the fact that the role of trace minerals in animal and human health is well established, they are the great forgotten nutrients in animal diets. Their physiological role is often underestimated and their presence in the feed in adequate quantities is taken for granted. However, they are necessary to maintain body function, to optimise growth and reproduction and to stimulate immune response and therefore determine the health status. Indeed, it is difficult to realize the impact of insufficient trace minerals, as symptoms of deficiency or mineral unbalances may not always be evident. (Falah, et al., 2017).

The 200 adults were selected for this study, in which 100 were males and 100 were females.

The Findings of the study were

- The age and gender distribution of the selected adults was found to be 30 males and 56 females were in the age group of 19 – 22 years, followed by 42 males and 31 females in the age group of 23 – 26 years.
- The results of educational qualification of the selected adults shows that were all the adults were literate. Fifty eight males and 57 Females were graduates and 27 and 25 males and females respectively were postgraduate.
- In occupational category, majority of males (38) and females (37) were students. The various other occupations among males and females were teachers (3 and 7 respectively), engineers (18 and 4 respectively) and self employed (19 and 24 respectively). While considering females, 16 of them were home makers.

- It was found that 40 males and 38 females belong to high income group; whereas 22 males and 25 females belong to low income group. The result also showed that 75 (males and females) comes under economically weaker group.
- The details of the family results, showed that 82 males and 71 females had upto 2 to 4 members, whereas 18 males and 29 females had 4 to 7 members in family. The above table signifies that majority of the adult's family was nuclear.
- While considering the BMI of adults, 7males and 21 females were under weight. Obesity was seen higher in adults in which males (50) were more obese in number than females (38) This indicates that adults were easily prone to other complications due to obesity.
- The WHR (Waist & Hip Ratio) of Males and Females. It was evident from the results that 71 females were in high risk and 14 males were in this risk category.
- It was observed that majority of males and females (86 and 84 respectively) are non-vegetarian.
- It was found that the Energy (1384.43 ± 15.58 kcal) consumption was lowered than the recommended dietary allowance. The Protein (64.58 ± 0.27 g) and Fat (27 ± 0.98 g) intake was observed to be sufficient in males.
- While considering the females mean dietary intake it was observed that Energy (1374.50 ± 9.21 kcal) intake was found lowered, whereas the protein (65.99 ± 2.23 g) and fat (28.09 ± 3.12 g) intake was found to be sufficient.
- The results that shows the mean nutrient intake of trace elements it was found that the intake of copper, zinc and chromium was 2.16, 9.26 and 48 μ g respectively in males.
- Measuring the mean nutrient intake of trace elements it was found that the intake of copper, zinc and chromium was 2.23, 9.34 and 47 μ g respectively in females.
- The results of the consumption of food sources of copper among males, reported that their daily consumption is limited to red gram dhal (4), almonds (16), cashew nut (13), gingelly seed (4) and coriander seeds (3). Majority of males consumed the above food sources weekly or monthly. Foods like goat liver (43) and crab (71)

were not consumed by majority of males. Poppy seeds (64) and soya bean (58) was also never consumed by most of males.

- While considering the consumption of food sources of females, they consumed foods like almonds (10), coriander seeds (10) and red gram dhal (10). Foods like poppy seeds (41), goat liver (54), crab (71) and soya bean (48) was not commonly consumed among females.
- It was found, that the millets like bajra and ragi were not consumed by males (57 and 51 males respectively). Zinc food sources were consumed in moderation by the selected males. The above table signifies the consumption of food sources of zinc in which the results showed that there majority of males never consume zinc food sources.
- The results of zinc intake of males, the crab and fish were never consumed (71 and 95 respectively). Wheat flour, cashew nut and almonds were consumed daily by limited females. This signifies that the zinc food sources was not well known among the females.
- It was evident that the chromium sources was mainly from gingelly seeds, mushrooms and coriander seeds. Majority of the sources were not consumed regularly among males.
- It was found, the sources like coriander and gingelly seeds were commonly used. Other sources were either rarely consumed or never consumed at all. This shows that chromium food sources were limited among females.

CONCLUSION

The role of trace elements in biological processing may provide vital clue for understanding the etiology of some diseases such as cancer. The ability of trace elements to function as substantial affecter in a variety of the processes necessary for life, such as regulating homeostasis and prevention of free radical damage, can provide an answer to the definite correlation between content of trace elements and many common diseases. In the past ten years, studies have focused extensively on determine the levels of trace elements in humans, as an attempt to understand the nature of relationships between

metabolism and trace elements. Thus, finding the dietary intake of trace elements will enable to understand the etiopathogenesis and provide a rapid diagnostic facility and also create effective treatment modalities.

It is important to regularly obtain up-to-date information on the minerals content and the variously commonly consumed food sources of trace elements used by human Eg. legumes, cereals, fruits and vegetables. This could paves way to a newer area of research by analyzing the dietary intake of trace elements and proper measures can be taken by intervention to enhance the intake levels of specific trace elements.

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APPENDIX I

INSTITUTIONAL HUMAN ETHICS COMMITTEE



Avinashilingam

Institute for Home Science and Higher Education for Women

University

(Estd. u/s 3 of UGC Act 1956)

Chairman

Dr. S. Ramalingam
Principal, PSG Institute
of Medical Sciences
& Research, Coimbatore

Member Secretary

Dr. S.Uma Mageshwari
Associate Professor,
Department of Food Service
Management & Dietetics

Members

Dr. S. Kowsalya
Dr.P.R.Padma
Mr. K.Arulmoli (Legal Expert)
Dr. N.S. Rohini
Dr. A. Saraswathy
Mrs. V. Mangayarkarasi
Dr.Subhashini K. Sripathi
Mrs. S. Radha Devi
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.Anitha Subash

19th March 2018

To

Ms. Mangaiandal.M .M
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Mangaiandal,

Ref: Your proposal No. IHEC/17-18/FSMD/05 entitled “Dietary intake of trace minerals (copper, zinc and chromium) among selected adults” submitted for approval of the IHEC on 14th December.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No.IHEC/17-18/FSMD/05 entitled “Dietary intake of trace minerals (copper, zinc and chromium) among selected adults” submitted by you. The Approval number for the same is AUW/ IHEC/ FSMD -17-18/XPD/05.

We wish you all the best in your research endeavours.

Regards.

S. Uma Mageshwari
Dr.S.Uma Mageshwari
Member Secretary



APPENDIX II

INFORMED CONSENT FORM

If you are uncomfortable in answering any of our questions during the course of the interview / biological sample collection, you have the right to withdraw from the interview / study at anytime. You have the freedom to withdraw from the study at any point of time. You will NOT be paid any remuneration for the time you spend with us for this interview / study. The information provided by you will be kept in strict confidence. Under no circumstances shall we reveal the identity of the respondent or their families to anyone. The information that we collect shall be used for approved research purposes only. You will be informed about any significant new findings – including adverse events, if any – whether directly or indirectly related to you or to other participants of this study, developed during the course of this research which may relate to your willingness to continue participation

Consent: The above information regarding the study, has been read by me/ read to me, and has been explained to me by the investigator(s). Having understood the same, I hereby give my consent to them to interview me. I am affixing my signature / left thumb impression to indicate my consent and willingness to participate in this study (i.e., willingly abide by the project requirements)

Signature / Left thumb impression of the Study Volunteer / Legal Representative:

Signature of the Mother with date:

Signature of the Participant with name:

APPENDIX III

QUESTIONNAIRE SCHEDULE TO ELICITE INFORMATION OF THE SUBJECT

BACKGROUND INFORMATION:

NAME :

AGE :

SEX : Male / Female

ADDRESS :

QUALIFICATION :

OCCUPATION :

FAMILY INCOME (Monthly) : Less than 10,000 10,000 to 20,000
 20,000 to 30,000 More than 30,000

RELIGION : Hindu / Christian / Muslim

FAMILY TYPE : Nuclear / Joint, No. Of Members in a family _____

ANTHROPOMETRIC MEASUREMENT:

HEIGHT _____ WEIGHT _____ BMI _____

WAIST CIRCUMFERENCE _____ HIP CIRCUMFERENCE _____

WHR (Waist Hip Ratio) _____

HEALTH STATUS:

Do you have any disease condition? Mention it below:

Diabetes Cancer Obesity Cardio Vascular Disease Hypertension
HIV Tuberculosis Liver disease Night blindness None

Do you have any Nutritional Deficiency disorder? Mention it below:

Iron Calcium Vitamin A Vitamin C Vitamin D Mal Nutrition None

APPENDIX IV

DIETARY PATTERN:

1. Are You Vegetarian Non-Vegetarian
2. 24 Hour recall method 3consecutive days:

DAY 1

Meal Frequency	Food Consumed	Quantity
EARLY MORNING		
BREAK FAST		
MID MORNING		
LUNCH		
EVENING		
DINNER		
BED TIME		

DAY 2

Meal Frequency	Food Consumed	Quantity
EARLY MORNING		
BREAK FAST		
MID MORNING		
LUNCH		
EVENING		
DINNER		
BED TIME		

DAY 3

Meal Frequency	Food Consumed	Quantity
EARLY MORNING		
BREAK FAST		
MID MORNING		
LUNCH		
EVENING		
DINNER		
BED TIME		

APPENDIX V

How many times you consume Copper, Zinc & Chromium rich foods, mention it (☑) in the following tables.

COPPER RICH FOODS

FOOD GROUP	FOOD STUFF	D A I L Y	W E E K L Y	M O N T H L Y	N E V E R	QUANTITY
GRAIN LEGUMES	Field bean <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Green gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Horse gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Red gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Red gram dhal <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Soya bean brown <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CONDIMENTS & SPICES DRY	Corriander seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Fenugreek seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Mace <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Nutmeg <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Omum <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pippali <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Poppy seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
NUTS & OIL SEEDS	Almond <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Cashewnut <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Gingelly Seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Linseeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Niger seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pine seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Sunflower seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ANIMAL MEAT	Goat Liver <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Beef Liver <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MARINE FISH	Korka <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MARINE SHELLFISH	Oyster <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Mub Crab <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
FRESH WATER FISH & SHELLFISH	Fresh Water Eel <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

ZINC RICH FOODS

FOOD GROUP	FOOD STUFF	D A I L Y	W E E K L Y	M O N T H L Y	N E V E R	QUANTITY
CEREALS & MILLETS	Amaranth seed <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Bajra <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Maize dry <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Ragi <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Wheat flour <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Wheat semolina <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Barley <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Jowar <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Riceflakes <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Raw Brown Rice <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Samai <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Varagu <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Wheat bulgur <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GRAIN LEGUMES	Bengal gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Black gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Cow pea <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Lentil whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Moth bean <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Peas dry <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Rajmah <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Soy bean <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Field bean Black <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Green gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Horse gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Rice bean <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
GREEN LEAFY VEGETABLES	Amaranth leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Garden cress <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Parsley <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
OTHER VEGETABLES	Corn baby <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Peas fresh <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CONDIMENTS & SPICES DRY	Nutmeg <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pippali <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Mace <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Poppy seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

	Cardamom <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Coriander seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Fenugreek seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Omum <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
NUTS & OIL SEEDS	Cashewnut <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Coconut kernel dry <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pistachio nuts <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Walnut <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Almond <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Groundnut <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Niger seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Safflower seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Gingelly seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Sunflower seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Garden cress seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Lin seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Niger seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pine seeds <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MUSHROOMS	Shiitake Mushroom fresh <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Oyster Mushroom dry <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MILK & MILK PRODUCTS	Panner <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Khoa <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
EGG & EGG PRODUCTS	Egg <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
POULTRY	Chicken <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Country hen <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ANIMAL MEAT	Goat <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Beef <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Rabbit <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MARINE FISH	Korka <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Padayappa <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MARINE SHELL FISH	Crab Sea <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Mud Crab <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
FRESH WATER FISH & SHELL FISH	Fresh water Eel <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Crab <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Gold Fish <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Prawn big <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Tiger Prawn <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

CHROMIUM RICH FOODS

FOOD GROUP	FOOD STUFF	D A I L Y	W E E K L Y	M O N T H L Y	N E V E R	QUANTITY
CEREALS & MILLETS	Rice flakes <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Amaranth seed <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Bajra <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Barley <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Rice puffed <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GRAIN LEGUMES	Rajmah <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Horse gram whole <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GREEN LEAFY	Amaranth <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Basella leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Betel leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Fenugreek leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Gogu leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pakchoi leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pumpkin leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Rumex leaves <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Spinach <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Mustard leave <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
OTHER VEGETABLES	Capsicum yellow <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Tomato green <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Onion stalk <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ROOTS & TUBERS	Lotus Root <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
FRUITS	Mango ripe <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

CONDIMENTS & SPICES DRY	Asafoetida	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Mace	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Coriander seeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Poppy seeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Onum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Cloves	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Pippali	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Cardomom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
NUTS & OIL SEEDS	Gingelly seeds Black	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Niger seeds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MUSHROOM	Oyster Mushroom	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MILK & MILK PRODUCTS	Panner	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Khoa	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MARINE FISH	Kulampaarai	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Manda clathi	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Tilapia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Sliver carp	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Vela meen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MARINE SHELL FISH	Crab	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Sea crab	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Oyster	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	