

*REVIEW*  
*OF*  
*LITERATURE*

## 2. REVIEW OF LITERATURE

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## **2.1. Nutrition Transition**

Nutrition transition refers to the changes in human dietary pattern over a period of time from traditional diets to westernized diets. Nutrition transition encompasses several other changes as economic, demographic and epidemiological changes. Nutrition transition took place in developed countries over a longer period of time as compared to developing countries where this change took place in just a few decades (drastic dietary change). For example, in China during 1970s, there was minimal technology usage and minimally processed foods were consumed. The occupation in both rural and urban areas was labor intensive, however with maximum technological advancements in all walks of life, consumption of soft drinks and other processed foods have become universal. Similar changes have occurred in other regions of the world especially middle and low income countries like Asia, North Africa, the Middle East, Latin America and sub-Saharan Africa (Popkin, 2004). There is increase in the proportion of calories derived from fat in low-income and middle-income countries. In higher-income countries, dietary fat accounts for 26–30% of caloric intake but the proportion of calories from total protein has remained unaltered (12% of the total calories). However, there has been a marked increase in the availability of animal protein, especially poultry and the consumption of red meat continues to rise in countries like China and Brazil. Per-capita consumption of vegetable oils and refined sugar has increased many folds in several countries. This

unhealthy component of the nutrition transition has contributed to a widespread rise in obesity and related chronic diseases (including metabolic and vascular diseases, particularly, type-2 diabetes and ischemic heart disease and some cancers). Hence, many countries around the world are facing the double burden of malnutrition i.e. under-nutrition due to micronutrient deficiency and over-nutrition due to increased availability of foods of animal origin, high in saturated fat and energy-dense processed foods rich in fats and sugar leading to Diet Related Non-communicable diseases (DR-NCDs) (Uauy, 2006 ; Anderson and Chu, 2007).

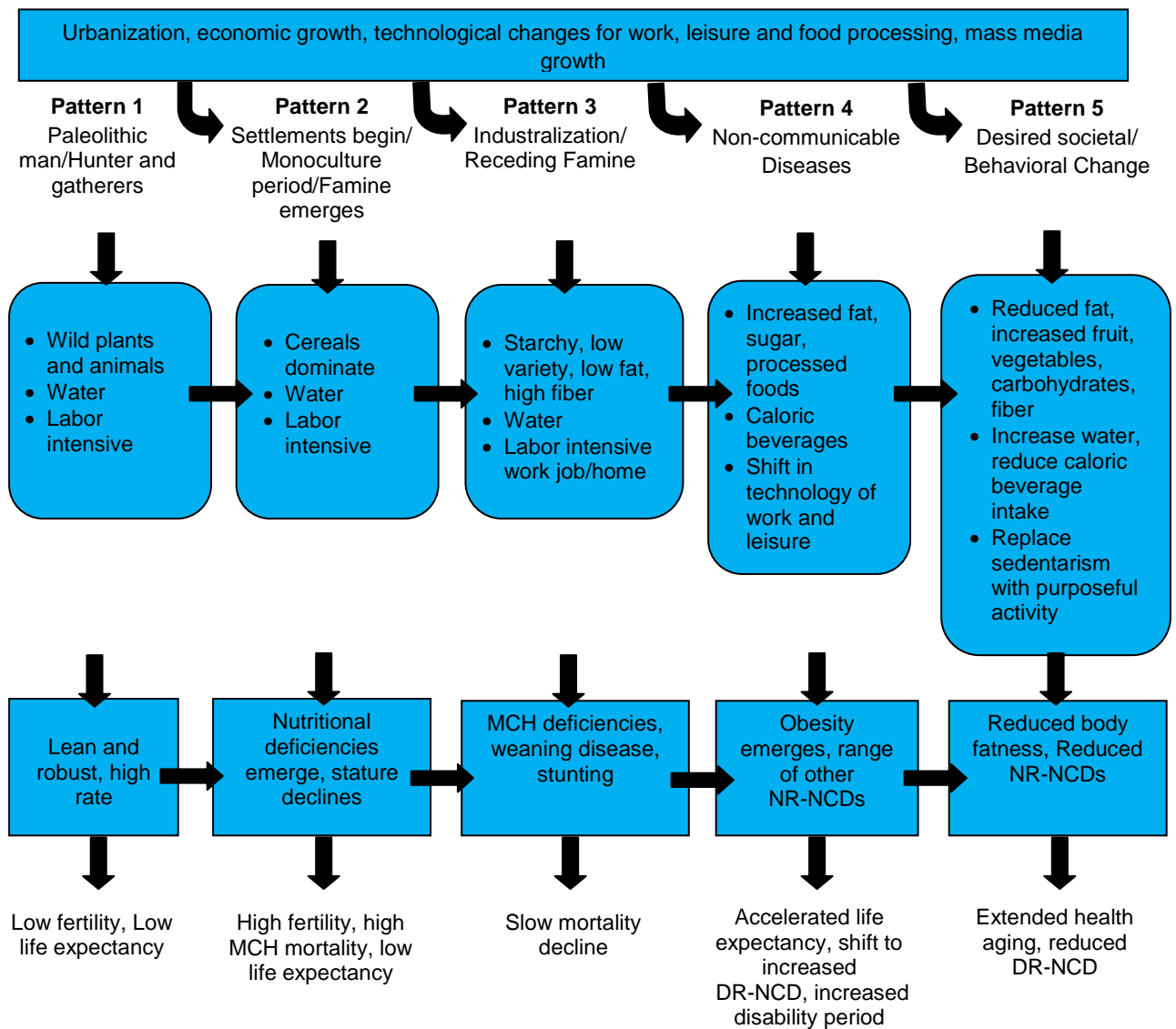
Along with the shift from traditional diets that were characterized by high fibre, low fat and sugar content to a westernized diet high in sugars, fat and low in fibre, there is occupational shift from labor-intensive jobs to more capital intensive, less strenuous work (Popkin, 2004). Other factors responsible for increase in consumption of refined, processed and energy-dense foods in place of grains, legumes and other sources of fibre are food abundance, increase in national wealth and urbanized lifestyle (WHO/FAO, 2003). Higher incomes are associated with greater consumption of sugars, total fat and animal fat leading to more energy-dense diets (WHO/FAO, 2003; Drewnowski and Darmon, 2005). In the fast-food trade, higher consumption demands more production and lowers the per unit price of the commodity which in turn encourages consumption of a larger (so-called super sized) serving. The addition of salt, sugar and coloring further enhances consumption of energy-dense fatty foods. The biological and behavioral regulation of human diets since Paleolithic age is not accustomed to resisting this temptation. Nationally representative data from US indicate that at least 40% of the increase in the prevalence of obesity over the past 25 years is reasonably attributed to the reduced unit price of food, especially foods high in fat and sugar (Lakdawalla and Philipson, 2002).

Around 5000 years ago, Indians were aware of the harmful effects of dietary ingredients which are evident from ancient scripture of the Bhagwad Gita (3100 BC). Food consumption patterns and health behavior have changed significantly in various societies, during transition from *Homo-sapiens* to *Homo economicus* populations. The nutrition transition has been quite rapid during the last 100–160 years, causing increased intake of saturated fatty acids (SFA), trans fat, refined carbohydrates and linoleic acid and decreased omega-3 fatty acids and flavonoids, from grain-fed cattle, tamed at farm houses, rather than meat from running animals, resulting in marked increase in morbidity and mortality due to NCDs. The population characteristics, such

as dietary intakes, in combination with sedentary behavior appear to be the main causes of poor social, mental and spiritual health as well as of hyperlipidemia, hyperglycemia, oxidative stress and inflammation which are important mechanisms in the pathogenesis and prevention of diet related NCDs (WHO/FAO, 2008; Rosengren et al, 2004; Popkin, 2006a; Simopoulos and De-Meester, 2009; De-Meester and Watson, 2008, Singh et. al, 2013). Therefore, dietary behaviors largely influence health conditions.

### **2.1.1. Nutrition Transition-A Historical Background**

The Paleolithic men were hunters and gatherers and their diet was characterized by consumption of omega-3 fatty acids, antioxidants, vitamins and minerals and protein rich foods with extensive physical activity. The people were lean and there was no clue of NCDs however, mortality rate was high due to infections and communicable diseases. As time progressed, man started to settle down in communities and agricultural practices came into being and named as “monoculture period” by Popkin (2002a). As agriculture became the major occupation of the people, setting up of industries also started and gradually significant dietary changes took place during the past 100-160 years. This dietary change brought about increased intake of saturated fatty acids (SFAs), trans fatty acids (TFAs) and linoleic acid and meat from grain fed cattle, tamed at farm houses, rather than meat from running animals. Thus, there was an increased intake of refined carbohydrates, saturated fat, trans fat, linoleic acid and salt and decreased intake of complex carbohydrates, essential amino acids, minerals, omega-3 fatty acids, vitamins and antioxidants (Singh et. al, 2010; Carrera-Bastos et. al, 2011; Singh et. al, 2011a). Such a type of diet is now called “Westernized diet.” These dietary changes in conjunction with Westernized lifestyle-sedentarism, mental stress, pollution, tobacco consumption and alcoholism, particularly after 1910, have caused damage to human genes, leading to emergence of phenotypes of NCDs (Marmot et. al, 2012; Pettee and Ainsworth, 2009; Frassetto et. al, 2009; Carrera-Bastos et. al, 2011; Singh et. al, 2005; Singh et. al, 2011b; Pednekar et. al, 2011; Teo et. al, 2009). Such a diet can also be called as pro-atherogenic diet (Singh et. al, 2005; Singh et. al, 2011b; Pednekar et. al, 2011; Teo et. al, 2009).

**Figure 2.1: Stages of Nutrition Transition**

Source: Popkin, 2002b; Popkin and Gordon-Larsen, 2004

### 2.1.2. Nutrition Transition-Causes and Consequences

It is a widely established fact that the nutrition transition towards poor quality, energy-dense diets and the increasing prevalence of chronic disease is deeply rooted in the process of globalization (Kennedy et. al, 2004; Hawkes et. al, 2007). Globalization refers to the liberated movement of capital, technology, goods and services associated with increase in income and changing lifestyles resulting into alteration in quality and quantity of diet (Mendez and Popkin, 2005 ; Hawkes et. al, 2007).

The change in availability and access to food is due to the changing food production, procurement and distribution processes of globalization. Such changes bring about a gradual shift in food culture, dietary consumption patterns and nutritional status of the population (Kennedy et. al, 2004). Globalization is therefore a dynamic process of both mass global change and local, contextualized differentiation. Therefore, globalization is bringing both “dietary convergence” and “dietary adaptation.” Dietary convergence is “increased reliance on staple grains, increased consumption of meat and meat products, dairy products, edible oil, salt and sugar and a lower intake of dietary fibre.” On the other hand, dietary adaptation is “increased consumption of branded processed and store-bought food, an increased number of meals eaten outside the home and consumer behavior driven by the appeal of new foods available” (Kennedy et. al. 2004). Convergence is brought about by changes in income and price while adaptation is driven by demands on time, increased exposure to advertisements and availability of new foods and emergence of new food retail outlets (Hawkes, 2007). A good example of Globalization was seen in Fiji during colonial British rule in 1800s. During that era, Indians were taken to Fiji to work as laborers in sugar plantations. With the migration of Indians to Fiji, their culture, food habits and lifestyle also migrated with them which brought about the blend of Indian and Fiji culture. The traditional Fiji diet consisting of root crops and fish flavored with little other than coconut milk (lolo) was soon started to diffuse with the Indian spices and Fijians then started to curry their meat to add more flavor and eat with roti (Indian flat bread). This trend became popular in the areas where Indians have settled especially urban areas and soon reached to Fijians that have migrated to the same place where Indians resided (Krause, 2011). Therefore, Fiji has experienced a shift towards westernized diet and simultaneously a shift away from consumption of traditional foods.

The globalization process is also responsible for the increasing number of supermarkets and hypermarkets in developed as well as developing countries. Supermarkets and hypermarkets are constantly replacing fresh or open food markets in developing nations and are the huge providers of processed higher-fat, added-sugar and salt-laden foods in developing countries (Popkin, 2006b). The increasing popularity of supermarkets can be understood from their food sales across time. The supermarket share of retail food sales increased from 15% to 60% from 1990 to 2000 in Latin America (Reardon and Berdegue, 2002). Packaged foods had the highest sales of about 55% from super/hypermarkets followed by independent stores (15%)



and standard convenience stores less than 15% in 2004 in Asia Pacific Region (Mohsin, 2005).

**Table 2.1: Globalization Process Linked with the Nutrition Transition**

Globalization Process	Dietary Implication
Growth of Transnational Food Corporations (TFCs) including supermarkets, fast food outlets and food advertising/promotion	Increased availability of processed foods (fast foods, snacks, soft drinks) Increases diversity of available products Accessibility Price Way a food is marketed
Liberalization of international food trade and foreign direct investment (FDI)	Imports change availability of foods and prices Investment changes types of foods available, their price and the way they are sold and marketed
Global food advertising and promotion	Shapes food preferences by affecting desirability of different foods

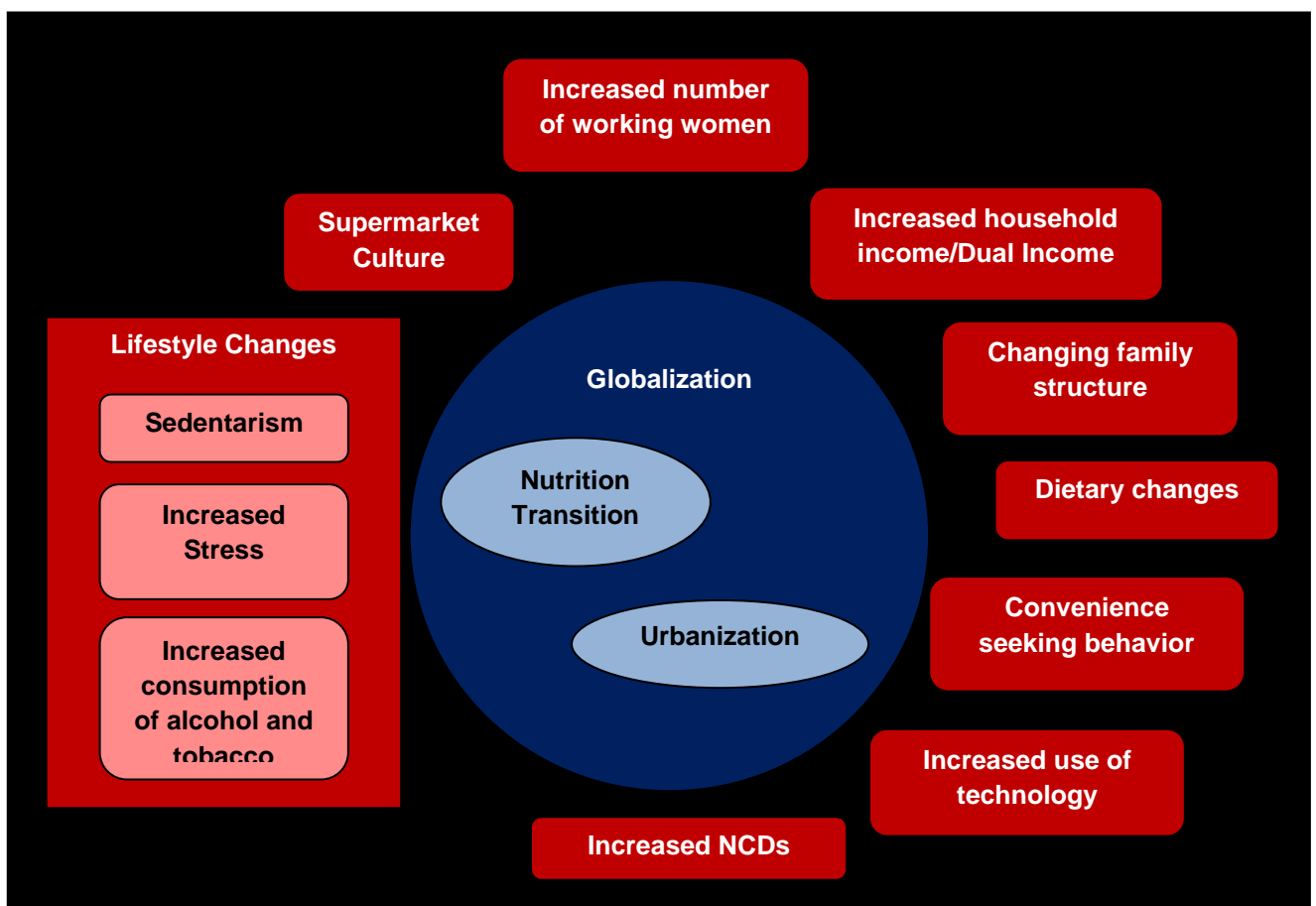
**Source: Hawkes et.al, 2007**

Urbanization is yet another major factor responsible for propelling the process of nutrition transition. A cross sectional study conducted among Cypriot children (n=1140, aged  $10.7 \pm 0.98$  years) showed an association of nutrition transition and urbanization with the adoption of westernized diet. It was revealed that children from rural areas consumed more traditional Mediterranean foods and were more likely to have meals with the family as compared to children from urban areas. This clearly shows the effect of urbanization on food habits according to the place of residence (Lazarou and Kalavana, 2009).

Number of studies have shown a positive correlation of increasing urbanization with incidences of diabetes, breast cancer, allergic diseases and asthma (Al-Moosa et. al, 2006; Hall et. al, 2005; Nicolaou et. al, 2005; Viinanen et. al, 2005).

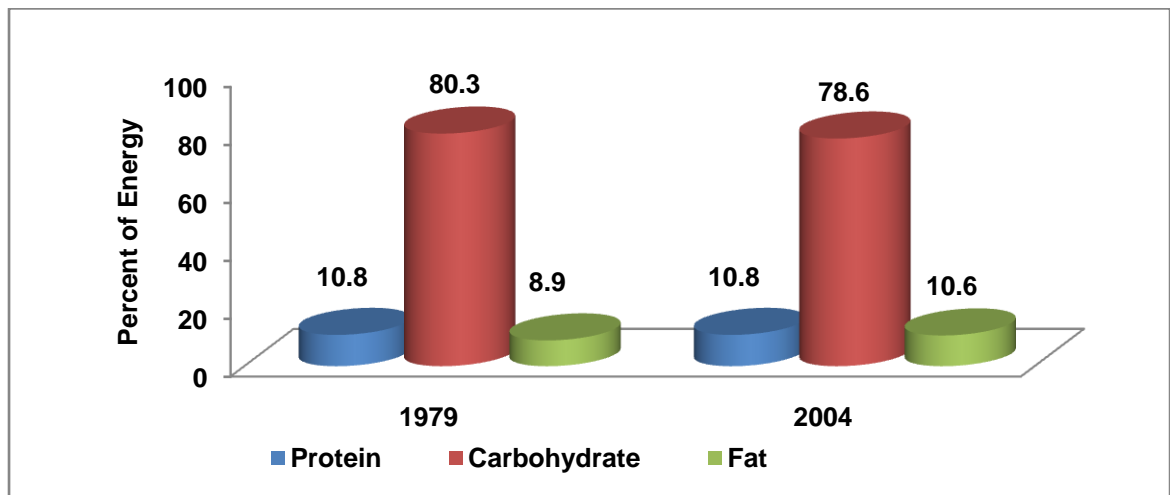
An anthropological study in Madras showed that the female urban middle class is shifting away from intensive food preparation at home to greater consumption of processed foods and meals outside the home (Caplan, 2002). Therefore, the changing lifestyle has altered diet, activity and subsequent imbalances that have led to the obesity epidemic. The factors responsible for rising obesity can be imposed on the global food production, marketing and distribution sectors including soft drink, fast food and other multinational food companies (most frequently linked with westernization of the world's diet) (Mendez and Popkin, 2005).

**Figure 2.2: Outcomes of the combined effect of Globalization, Nutrition Transition and Urbanization**



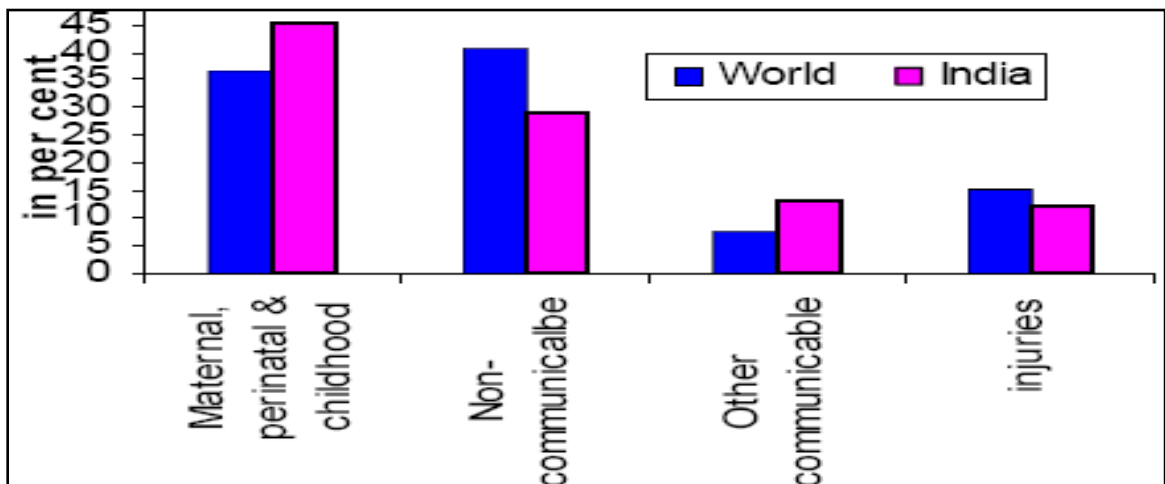
### 2.1.3. Nutrition Transition in India

The scenario of nutrition transition in India can be explained from the food consumption data of the year 1979 and 2004 as given in the Figure 2.3

**Figure 2.3: Nutrient Intake as percent of Energy consumption in India**

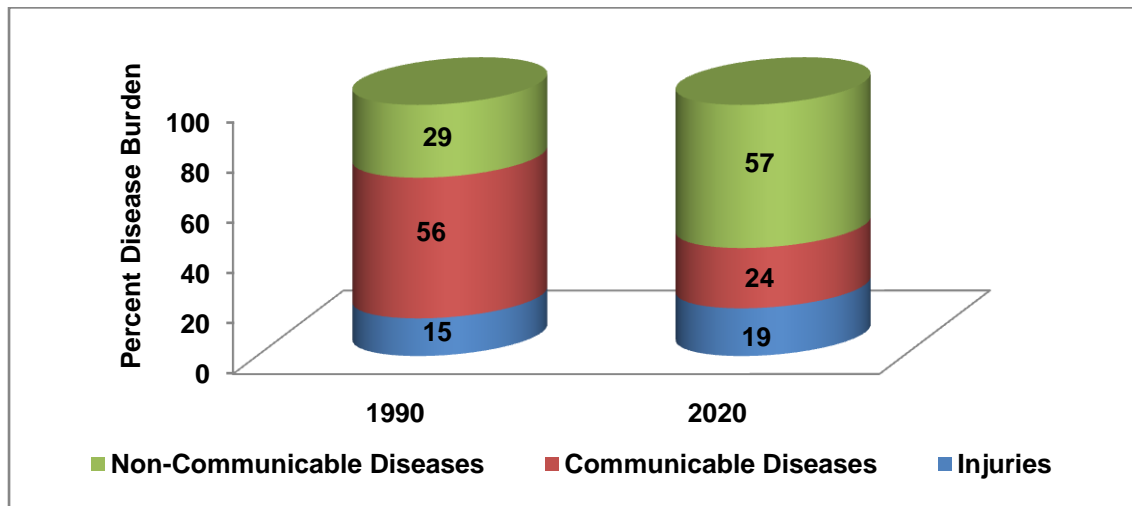
Source: Ramachandran, 2007

It has also been observed that from 1979 to 2004, energy intake from protein remained same among Indian population while energy intake from carbohydrates has decreased by 1.7% while the same percentage has increased from fats (Figure 2.3). Weight gain has also been observed and it is more in urban as compared to rural areas. The weight gain appears to be mainly due to increase in body fat and fat fold thickness (Ramachandran, 2007).

**Figure 2.4: Distribution of Disease Burden in India and the World**

Source: Ramachandran, 2007

Non-communicable diseases are emerging as major public health problem in India. More than 50% of the world's share of non-communicable diseases is in India (Figure 2.4) (Ramachandran, 2007).

**Figure 2.5: Disease Burden Estimates (1990) and Projections (2020) in India**

**Source: Ramachandran, 2007**

The prevalence of non-communicable diseases in India would be almost same in 2020 as it was of communicable diseases in 1990 (Figure 2.5). This clearly shows that there would be replacement of the kind of disease burden in India between two time periods (Ramachandran, 2007).

Thus, there is a need to choose healthy diet which aims at maintaining or improving health of an individual. For this, consumers, state and the food industries should make efforts to bring about the positive change. The role of food industries in promoting the same can be:

- Reducing the fat, sugar and salt content of processed foods.
- Ensuring that healthy and nutritious choices are available and affordable to all consumers.
- Practicing responsible marketing especially those aimed at children and teenagers (WHO, 2013).

## **2.2. What are Processed Foods?**

The U.S. Food and Drug Administration defined “processed food” as “any food other than a raw agricultural commodity and includes any raw agricultural commodity that has been subject to processing, such as canning, cooking, freezing, dehydration, or milling.” By this definition, nearly all foods served in restaurants and many grocery store products come under the umbrella of processed foods ([www.cdc.gov](http://www.cdc.gov)). Yet another definition of processed foods given by Canadian Processed Food

Regulations is “processed means, in respect of a food product, canned, cooked, frozen, concentrated, pickled or otherwise prepared to assure preservation of the food product in transport, distribution and storage, but does not include the final cooking or preparation of a food product for use as a meal or part of a meal such as may be done by restaurants, hospitals, food centres, catering establishments, central kitchens or similar establishments where food products are prepared for consumption rather than for extended preservation” (Processed Food Regulations, Canada, 2013).

### 2.2.1. Classification of Processed Foods

Processed foods have been classified by various agencies of different countries. In India, Ministry of Food Processing Industries have classified processed foods as “Primary Processed Foods” and “Value added Processed Foods” as given in the Table 2.2

**Table 2.2: Classification of Processed foods**

Primary Processed Foods	Value Added Processed Foods
Packed fruits and vegetables	Processed fruits and vegetables-juices, jams, pickles, squashes, concentrates.
Packed milk	Processed dairy products-ghee, paneer, cheese, butter, ethnic Indian products.
Unbranded edible oil	Branded edible oil
Milled rice	Breads
Flour	Biscuits
Tea	Snack foods
Coffee	Pasta based foods
Sugar	Processed meat, Poultry and marine products
Pulses	Confectionery and chocolates
Spices	Alcoholic beverages-beer, spirits, wine
Salt	Aerated and malted beverages

**Source: Rabo India Finance Pvt. Ltd, 2005**

International Food Information Council Foundation (IFIC) has classified processed foods in five categories on the basis of complexity of processing and the physical, chemical and sensory changes occurring in food as a result of processing techniques. The classification is as given below,

- (a) **Category A/ Minimally processed foods:** “Foods that retain most of their inherent properties and include such foods as washed and packaged fruits and vegetables and roasted nuts.” For e.g. Washed and packaged fruits and vegetables, bagged salads, roasted and ground nuts and coffee beans.

- (b) **Category B/ Foods processed for preservation:** Foods that are processed for preservation, nutrient enhancement and freshness, falls under this category. For e.g. canned tuna, beans and tomatoes, frozen fruits and vegetables, pureed and jarred baby foods.
- (c) **Category C/ The “mixtures of combined ingredients” category:** This category of processed foods include foods containing sweeteners, spices, oils, colors, flavors and preservatives used for the purpose of promoting safety, taste and visual appeal. For e.g. some packaged foods, such as instant potato mix, rice, cake mix, jarred tomato sauce, spice mixes, dressings and sauces and gelatin.
- (d) **Category D/ Ready-to-eat processed foods:** This category comprises of processed foods which involve advanced processing techniques than that used in category ‘C’ in order to arrive at the final product. Breakfast cereals, flavored oatmeal, crackers, jams and jellies, nut butters, ice cream, yogurt, garlic bread, granola bars, cookies, fruit chews, rotisserie chicken, luncheon meats, honey-baked ham, cheese spreads, fruit drinks and carbonated beverages comes under this category.
- (e) **Category E/ Prepared foods/meals:** “It includes foods packaged for freshness and ease of preparation such as frozen dinners and entrees as well as prepared daily foods.” For e.g. Prepared foods and frozen meals, entrees, pot pies and pizzas (IFIC, 2010).

Another classification of processed foods is on the basis of the extent and purpose of industrial processing carried out on the food products. It was suggested by Monteiro and is the most widely used classification system.

**Group 1: Unprocessed or minimally processed foods:** No processing or usually physical processes are used to make single whole food. It includes fresh, chilled, dried, frozen, vacuum packed fruits and vegetables, grains, beans and pulses, fruits and 100% unsweetened fruit juices, unsalted nuts and seeds, meats, poultry and fish, pasteurized milk, yogurt, eggs, tea, coffee, herb infusions, tap water and bottled spring water.

**Group 2: Processed culinary or food industry ingredients:** It involves extraction and purification of components of single whole foods, resulting in production of ingredients used in the preparation and cooking of dishes and meals made up from Group 1 foods in homes or restaurants or in the manufacturing of Group 3 foods by food industries. It includes vegetable oils, margarine, butter, milk cream lard, sugar, sweeteners, salt, starches, flours and “raw” pastas and noodles (made from flour with the addition only of water) and food industry ingredients usually namely, high fructose

corn syrup, lactose milk and soy proteins, gums, preservatives and cosmetic additives.

**Group 3: Ultra-processed food products:** It involves processing of a combination of Group 1 foods and Group 2 ingredients to create durable, accessible, convenient and palatable ready-to-eat or ready-to-heat food products apt to be consumed as snacks or desserts or to replace home-prepared dishes. It includes breads, biscuits, cookies, cakes, pastries, ice cream, jams, canned fruits, chocolates, confectionery (candies), cereal bars, breakfast cereals with added sugar, chips, crisps, sauces, savoury and sweet snack products, cheese, sugared fruit and milk drinks and sugared and “no-cal” cola and other soft drinks, frozen pasta and pizzas, pre-prepared meat, poultry, fish, vegetable and other recipes, processed meat, hot dogs, sausages, burgers, fish sticks, canned or dehydrated soups, stews and pot noodle, salted, pickled, infant formulas and baby food (Monteiro et. al, 2010c).

Based on the classification by Monteiro et al (2010c), a study conducted in Canada found that the household expenditures and dietary energy availability dropped down for unprocessed or minimally processed foods and culinary ingredients and shifted to ready-to-consume products. The share of ready-to-consume products rose from 28.7% to 61.7% and the increase was especially noteworthy for those foods that were ultra-processed. The most important factor that has driven changes in Canadian dietary patterns between 1938 and 2011 was the replacement of unprocessed or minimally processed foods and culinary ingredients by ready-to-consume ultra-processed products (Moubarac et al, 2014).

### 2.2.2. Characteristics of processed packaged foods

Processed foods are durable, easily accessible (almost everywhere and throughout the year), attractive, ready-to-eat or ready-to-heat products. They have longer shelf life by reduced microbial deterioration, easy to transport to long distances and convenient to carry and cook (involves fewer steps in preparation by shortened preparation time and cooking time) (<http://www.theatlantic.com/health/archive/2010/11/how-ultra-processed-foods-arekillingus/65614/> and <http://www.eufic.org/page/en/page/FAQ/faqid/do-processed-foods-offer-any-benefits/>).

With these as advantages, processed foods have some disadvantages too. They are high in energy, highly palatable leading to habitual and compulsive consumption,

usually marketed in large portion sizes and extensively and sophisticatedly advertised (Monteiro et. al, 2012; Ludwig, 2011). All these factors challenge the normal processes of appetite control, cause over-consumption resulting in obesity and associated disease. Nutrient content-wise, processed foods are high in total fat, saturated or trans-fats, sugar and sodium and low in micronutrients and other bioactive compounds and dietary fiber (Monteiro et. al, 2011).

### **2.2.3. Factors Responsible for Increased demand for Processed Food**

There is a growing demand for processed foods in high income Asian countries like Japan, Korea, Taiwan as well as low income countries like India. Homemade meals are replaced by convenience or processed foods (Market Analysis Report, 2010; Huang and Bouis, 1996). This replacement is due to the nutrition transition and globalization. The changing lifestyle is not only limited to the urban areas but also spreading in rural areas. Lifestyle changes include urbanization, changing family composition (from joint families to nuclear families and singles), increasing number of working women, increasing disposable income and affordability, less time for cooking, hectic lifestyles, etc (TSMG, 2009; Vijayabaskar and Sundaram, 2012; Huang and Bouis, 1996; Popkin et al, 2006b; Mont and Power, 2009; Market Analysis Report, 2010). Rapid increase in disposable income in India coupled with changing attitudes towards health and hygiene are additional factors responsible for growing demand of processed foods. Simultaneously, changes in taste/variety, advertisement, packaging style, growing brand consciousness, exposure to Western products, introduction of food categories that are new to the Indian palate and new product variants catering to diversified tastes are ensuring higher acceptability of processed food products. All these factors create a strong environment for the accelerated growth of processed foods (TSMG, 2009).

A case study from Japan clearly highlights the association between demographic changes and changing food habits. Food habits in Japan are considered to be the most healthy but due to the demographic changes Japanese are also adopting westernized diets which is known to be high in salt, sugar and fat. Parallel to this obesity is also increasing in Japan. Though, the increase in obesity is not significant (3% of the population) still it is a major public health concern. Younger population in Japan is more influenced by westernized diet as compared to older adults (Market Analysis Report, 2010). Therefore, to enumerate, factors responsible for increasing demand of processed foods are:



- Increased urbanization, migration or social mobility.
- Changing family structure: increasing nuclear families, singles living away from home.
- Increasing income.
- Increasing number of working women.
- Eating out pattern.
- Convenience seeking behavior.
- Adding variety to menu.

#### **2.2.4. Advent of Food Processing and Food Processing Industries**

Food processing dates back to the prehistoric ages when crude processing included slaughtering, fermenting, sun drying, preserving with salt and various types of cooking methods such as roasting, smoking, steaming, and oven baking. Salt preservation was common for foods that constituted warrior and sailor's diets, until the introduction of canning methods. Evidence for the existence of these methods can be found in the writings of the ancient Greek, Chaldean, Egyptian and Roman civilizations as well as archaeological evidence from Europe, North and South America and Asia. These tried and tested processing techniques remained essentially the same until the advent of the industrial revolution. Examples of ready-meals also exist from pre-industrial revolution period such as the Cornish pasty and Haggis (a kind of savory pudding). Food processing has also helped to create quick and nutritious meals for busy families. Modern food processing technology in the 19th and 20th century was largely developed to serve military needs. In 1809 Nicolas Appert invented a vacuum bottling technique that supplied food to French troops and this contributed to the development of tinning and then canning by Peter Durand in 1810. Initially, tinning and canning was expensive and health hazardous due to the lead used in cans. Later, pasteurization technique was discovered by Louis Pasteur in 1862 which ensured microbiological safety of the food. In the 20th century, during the World War II, there was expanding consumer society in developed countries which contributed to the growth of food processing with advances like spray drying, juice concentrates, freeze drying and the introduction of artificial sweeteners, coloring agents and preservatives such as sodium benzoate. In the late 20th century, products such as dried instant soups, reconstituted fruits and juices and self cooking meals such as Meal Ready-to-Eat food ration were developed. During second half of the 20<sup>th</sup> century, Western Europe and North America, witnessed a rise in the pursuit of convenience. Food processing companies marketed their products especially to

middle-class working wives and mothers. Frozen foods found their success in sales of juice concentrates and "TV dinners." Processors utilized the perceived value of time to appeal to the postwar population and this same appeal contributed to the success of convenience foods of today ([http:// www.caaa.in/ Image/food%20processing%20book.pdf](http://www.caaa.in/Image/food%20processing%20book.pdf)). Therefore, convenience foods often termed as processed packaged foods serve the growing demand of taste and convenience of the population ([http://en.wikipedia.org/wiki/Food\\_processing](http://en.wikipedia.org/wiki/Food_processing)).

### **2.2.5. Food Processing Industry in India**

Food processing industry is the fifth largest industry in India in terms of production, consumption, export and growth. Indian processed foods sector stood at USD 157 billion in 2012 and it is expected to reach USD 255 billion by 2016 with 13 percent growth rate per annum (Indian Food Processing Industry-Opportunities and Outlook-2015, 2012; Bowman et. al, 2004). The upward mobility of income classes is likely to increase the demand of processed foods as has already been demonstrated in Europe and USA and more recently in several countries in South East Asia. With rapid increase in the per capita income and purchasing power along with increased urbanization and improved standards of living, it is estimated that 300 million upper and middle class consume processed foods. The share of the value added products in processed foods would almost double from US \$44 billion currently to US \$88 billion during 2010 to 2014-15, growing at the rate of 15%. India ranks second largest food producer in the world next to China (Rabo India Finance Pvt. Ltd, 2005).

The Indian food industry is mainly unorganized with 75% of the processing units belonging to the unorganized sector while only 25% fall under organized sector. The organized sector is small but its growth rate is fast. The food production is expected to double in the next 10 years and the consumption of value added food products is expected to grow at a much faster pace. Food and grocery comprise of the largest share of the expenditure thus offering a lot of scope for the food-processing industry. According to National Council of Applied Economic Research (NCAER) data, the consuming class, with an annual income of US \$980 (Rs 45,000) or above constituted over 80% of the population in 2009-10. The increase in income levels and higher tendency to spend provides great opportunities for companies across various sectors. Food and grocery takes away 57% from the consumer's wallet. India has a relatively younger population with close to 55% of population in the age group of 20-59 years. This age group shares the highest consumption percentage and therefore,

this trend is expected to provide a further boost to the growth of food consumption in India. Changing lifestyles, increase in literacy and exposure to western lifestyle by increasing number of urban consumers has led to change in mindset and preferences. Increase in the population of working women and increase in nuclear double income families in urban areas are some of the other factors that are influencing the lifestyles. As a result, there has been an increase in demand for processed, ready-to-cook and ready-to-eat foods. According to Euromonitor, money spend by Indians on meals outside the home has more than doubled in the past decade to about US \$5 billion a year, and is expected to further double in the next 5 years (Rabo India Finance Pvt. Ltd, 2005).

#### **2.2.6. Sub-divisions of Food Processing Industry in India**

- Packaged/Convenience foods (namely, pasta, breads, cakes, pastries, rusks, buns, rolls, noodles, corn flakes, rice flakes, ready to eat and ready to cook products, biscuits etc).
- Biscuits
- Bread
- Confectionery
- Ready-to-eat foods
- Aerated soft drinks

#### **2.2.7. Composition of Processed Foods**

Several studies have been carried out to assess the nutritional quality or nutrient composition of processed foods in various parts of the world. The nutritional quality of the processed food products depend on the extent and purpose of industrial processing techniques applied to the food products. Based on the extent and purpose of processing techniques processed foods are classified as, “unprocessed/minimally processed foods”, “processed culinary ingredients” and “ultra processed ready-to-eat or ready-to-heat” food products. The production and consumption of ultra-processed foods have increased in recent decades. According to the classification, ultra-processed foods include ready-to-eat foods, cakes, pastries, soft drinks, burgers and chips which are high in simple carbohydrates and lipids (Monteiro, 2009). Ultra-processed products are usually sold in large portion sizes, are highly palatable, are intended to be habit forming, extensively advertised and marketed and displace food-based dishes and meals (Moodie et. al, 2013;

Monteiro et. al, 2012; Ludwig, 2011). Studies in Brazil and Canada have shown that processed and ultra-processed products are more energy dense, have more free sugars, sodium and saturated fats and have less fibre than the combination of unprocessed or minimally processed foods and culinary ingredients (such as oils, flours, sugar, and salt) made into dishes and meals (Monteiro et. al, 2011; Moubarac et. al, 2013). Therefore, diets that include a large amount of ultra-processed foods are likely to be nutritionally unbalanced and unhealthy (Monteiro, 2009; Monteiro et al, 2011).

Processed foods and restaurant foods often contain higher sodium contents for either palatability or food safety reasons and thus the trend is likely to contribute to high sodium consumption (He and MacGregor, 2009). An analysis done using National Health and Nutrition Examination Survey (NHANES) 2003-2008 data on 25,351 Americans aged  $\geq 2$  years determined the contribution of processed food to total dietary intakes. It was revealed that proportional energy contribution was highest by the food category “ready-to-eat processed foods” (34%) followed by “mixtures of combine ingredients” (17%), “minimal processed foods” (14%), “foods processed for preservation” and “prepared meals” (3%). Daily total sugar contribution was proportionally high by “ready-to-eat processed foods” (45%) followed by “mixtures of combined ingredients” (11%) and least by “minimally processed foods” (2%). Vitamin C contribution was highest by “foods processed for preservation” (29%) followed by “ready to eat processed foods” (25%) and “mixtures of combined ingredients” (3%). The data concluded that ready-to-eat processed foods contributed more of unhealthy nutrients (energy-34%, total sugar-45% and added sugars-60%) and relatively less healthy ones (Vitamin C-25%, Vitamin D-23%, Calcium-23 and Potassium-24%). “Minimally processed” foods provided proportionally low contributions to daily energy and sugar intake with a large percentage of contributions to the daily intake of several nutrients essential for nutrient adequacy, disease prevention and overall good health (fiber-20% and protein-26%). The “minimally processed” and “ready-to-eat processed foods” are at the end of the processed food continuum, but both make prominent contributions to nutrients to be encouraged and to be reduced (Eicher-Miller et. al, 2012).

According to a study conducted in Europe, processed foods are assumed to be the main source of sodium in the diet (about 70-75% of the total intake) of the population, with about 10-15% from naturally occurring sodium in unprocessed foods and about 10-15% of sodium from discretionary sources such as sodium added during cooking

and at the table. The content of sodium as sodium chloride in processed foods may be much higher in bread- 20 mmol/100g, cheese- 30 mmol/100g, salted butter- 40 mmol/100g and lean raw bacon-80 mmol/100g (EFSA, 2005). A study in UK revealed that 80% of the total salt consumption among the population was through processed foods and foods served at canteens and restaurants. Only 15% and 5% contribution was from “during cooking or at the table” and “naturally present in the food”, respectively (He and MacGregor, 2009). Similar results were observed in a cross-sectional study among 655 Chinese postmenopausal women with pre-hypertension. The major contributors of non-discretionary salt were soup (21.6%), rice and noodles (13.5%), baked cereals (12.3%), salted/ preserved foods (10.8%), Chinese dim-sum (10.2%) and sea foods (10.1%). Discretionary salt use in cooking made a modest contribution to overall intake (Liu et. al, 2014). A cross sectional study in Greece among 4,580 children aged 10-12 years showed that 20% of the children had more than 2200 mg/day recommended sodium intake, excluding salt added at table and during cooking. The study revealed that 34% of sodium intake was from 'hidden' sources namely, bread, processed cereals and white cheese (Magriplis et. al, 2011). An increase in the consumption of highly salted processed foods resulted in increase in salt intake. The average salt intake in most countries around the world is approximately 9 to 12 g/day, with many Asian countries having mean intakes more than 12 g/day. Salt intake is commonly more than 6 g/day in children older than 5 years and increases with age (Brown et. al, 2009). Salt intake among children in developed countries has increased due to the increasing consumption of processed foods accounting for approximately 80% of total salt intake. The processed, restaurant, fast foods and snacks are generally very high in salt, fat and sugar. It is possible that children from the age of 3 to 4 years onward consume as much salt as adults (He and MacGregor, 2010).

The efforts to reduce salt content in processed foods by various countries namely, China, Japan, UK, Finland, Portugal and US reflected that processed foods are the major contributors of salt in diet of the populations. These countries brought about regulations to reduce sodium content in processed foods, labeling of processed and prepared foods, public education and collaboration with the food industry (He and MacGregor, 2009). Though, salt content in processed foods has been reduced through systematic measures in many European countries, they are still considered to be the main contributors to dietary sodium intake (EFSA, 2005).

Monosodium glutamate (MSG), the sodium salt of glutamic acid, is a food additive used as a flavoring agent to improve taste. MSG is frequently added to processed foods and other food preparations, particularly in Asian cuisine. Animal studies indicated that MSG can induce hypothalamic lesions and leptin resistance, thereby possibly influencing energy balance, leading to overweight. An association between MSG intake and overweight was observed in a cross-sectional study among 752 healthy Chinese women aged 40 to 59 years. Twenty four hour dietary recall was taken to quantify MSG usage during food preparation. Results showed that 82% of participants used MSG. Average MSG intake was 0.33 gram/ day. MSG intake was found to be positively associated with BMI, after adjustment for potential confounders including physical activity and total energy intake. Prevalence of overweight was significantly higher in MSG users than non-users. For users in the highest tertile of MSG intake compared to non-users, the multivariable-adjusted odds ratios of overweight were 2.10 (95% CI, 1.13–3.90, P for trend across four MSG categories=0.03) and 2.75 (95% CI, 1.28–5.95, P=0.04). Therefore, MSG intake may be associated with increased risk of overweight independent of physical activity and total energy intake (He et. al, 2008).

Added sugar is another “nutrient of concern” (Usmanova and Thor, 2003). The term "added sugars" refers to refined or industrially produced sugars (usually sucrose) used as ingredient in the processed foods or added in home-made food or at the table. Study carried out among 983 children aged 4-14 years in Denmark revealed that major contributors of added sugars in the diet of the children were “sweets, cakes and table sugar” (47.5%), “soft drinks”(17.9%) and “sweetened fruit juices” (17.7%) while only a small portion was derived from fruit (5.6%), cereals (2.5%) and milk products (3.7%). The food products which formed the major sources of added sugar were typically processed foods (Lyhne and Ovesen, 1995). Various other studies have shown that ready-to-eat foods are usually high in sugar (Finkelstein et. al, 2005; Lakdawalla et. al, 2005).

Sugar has many disguises. It is very usual that small amount of various type of sugars are listed in ingredients list and therefore, none of the sugars are placed as first few ingredients although the food may be high in sugar content. It has also been observed that sugar masquerades as healthy ingredient when the terms like honey, rice syrup or organic dehydrated cane juice is used instead of sugar. The various alternative sources or names used for sugar are given in Table 2.3

**Table 2.3: Alternative Sources/Names of Sugar**

<ul style="list-style-type: none"> <li>• Agave Nectar</li> <li>• Barley Malt Syrup</li> <li>• Beet Sugar</li> <li>• Brown Rice Syrup</li> <li>• Brown Sugar</li> <li>• Cane Crystals (or, even better, "cane juice crystals")</li> <li>• Cane Sugar</li> <li>• Coconut Sugar, or Coconut Palm Sugar</li> <li>• Corn sweetener</li> <li>• Corn syrup, or corn syrup solids</li> <li>• Dehydrated Cane Juice</li> <li>• Dextrin</li> </ul>	<ul style="list-style-type: none"> <li>• Dextrose</li> <li>• Evaporated Cane Juice</li> <li>• Fructose</li> <li>• Fruit juice concentrate</li> <li>• Glucose</li> <li>• High-fructose corn syrup</li> <li>• Honey</li> <li>• Invert sugar</li> <li>• Lactose</li> <li>• Maltodextrin</li> <li>• Malt syrup</li> <li>• Maltose</li> </ul>	<ul style="list-style-type: none"> <li>• Maple syrup</li> <li>• Molasses</li> <li>• Palm Sugar</li> <li>• Raw sugar</li> <li>• Rice Syrup</li> <li>• Saccharose</li> <li>• Sorghum or sorghum syrup</li> <li>• Sucrose</li> <li>• Syrup</li> <li>• Treacle</li> <li>• Turbinado Sugar</li> <li>• Xylose</li> </ul>
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**Source: Dolson, 2014**

In recent years, food industry has replaced sucrose with fructose in number of processed foods as an inexpensive alternative of sucrose. Fructose is extensively used in soft drinks, baked goods, condiments, prepared desserts and other processed foods as "high-fructose corn syrup" (Elliott et. al, 2002). A national sample of 15,010 Americans aged 3 years and older revealed that major contributors of added sugars in their diets were sweetened grains (cookies, cakes) (12.9%), breakfast cereals (4.4%), sugars/sweets (table sugar, honey, syrups, candies, jams, jellies, gelatin desserts) (16.1%), soft drinks (33%), soft drinks-low calorie (0.1%), fruit drinks (9.7%) and fruit drinks-low calorie (<0.1%) (Guthrie and Morton, 2000). Soft drinks and sweet soups fall in the category of "sugar sweetened beverages." Data from China showed that 47% of the added sugars come from sugar sweetened soft drinks and the same is the top food source for calories in the American diet which accounts for 7% of the total energy intake among Americans (Ko et. al, 2010; Nielsen and Popkin, 2004). With the increasing consumption of soft drinks and cordials they have become the major contributors of added sugar in children's diet (Ludwig et. al, 2001b; Somerset, 2003). Various studies have supported that sugar-sweetened beverages (SSBs) play an important etiologic role in obesity risk (Bray et. al, 2004; Gross et al, 2004; Popkin and Nielsen, 2003). Soft drinks/fluid milk/sugars and cakes, pastries and pies remained the major food sources for intake of total sugar, total carbohydrates and total energy during the past three decades.

Carbonated soft drinks were the most significant sugar source across the entire three decades (Basu et. al, 2013).

Various countries have worked towards the estimation of trans fatty acid (TFA) content in food products in order to bring down the TFA level and alert authorities to formulate strict regulations to check the same. TFAs are commonly found in bakery products, shortenings, margarines and cooking oils (Narkwichian et. al, 2009). To validate this, a multinational study was carried out to examine the industrially produced trans fatty acids content in 43 servings of fast foods from McDonald's and KFC outlets in 20 countries. It was revealed that TFA content (in chicken nuggets and French fries) varied from less than 1 g in Denmark and Germany to 10 g in New York (McDonald's) and 24 g in Hungary (KFC). Fifty percent of the 43 servings contained more than 5g of trans fat per serving. This amount of TFA is associated with 25% increase in the risk of ischemic heart disease. The cooking oil used for french fries in McDonald's outlets in the United States and Peru contained 23% and 24% trans fatty acids, respectively, whereas the oils used for french fries in many European countries contained only about 10% trans fatty acids, with the lowest of 5% to 1% in Spain and Denmark. At KFC, some values for trans fatty acid content were above 30% (Stender et. al, 2006).

Another study carried out in Vancouver, Canada to determine the fatty acid content of 200 foods revealed that the range of trans fatty acids in 17 brands of crackers was 23 to 51% of total fatty acids, representing the difference of 1 to 13 g trans fatty acids per 100g of cracker. The results highlighted that there was wide variability in trans fatty acid content among foods within a product category (Innis et. al, 1999). Similarly, Ghafoorunissa (2008), highlighted that the vanaspati (Partially Hydrogenated Vegetable Oils-PHVO) used in Indian cooking and in the preparation of commercially fried, processed, bakery, ready-to-eat and street foods contain up to 40% TFA. TFA content in Indian sweets and biscuits ranged from 6-26% and 30-40%, respectively. According to a study, trans fatty acids in Iranian fast foods (sausage, calbas, hamburgers and pizzas) were found to be 23.6% to 30.6% of total fatty acids in the food products (Asgary et. al, 2009).

An investigation carried out in Bangkok on 24 samples of bakery products and 6 samples of partially hydrogenated vegetable oils revealed that the highest TFA content was found to be in shortening (1.84 to 3.37 g/100g of food) followed by butter cookie (0.25 to 5.27g/100g), margarine (1.54 to 1.89g/100g), rich butter bun (0.21 to



0.88g/100g), crispy pie (0.41 to 0.58 g/100g), brownie (0.18 to 0.67 g/100g), croissant (0.14 to 0.83 g/100g), cake cream roll (0.16 to 0.73 g/100g), cracker (ND to 0.15 g/100g) and sandwich chocolate cookie (ND to 0.14 g/100g). The mean TFAs value in all selected foods ranged from 0.14 to 2.43 g/100g of food while the highest amount of TFA were found in butter cookie (5.07 g/100 g) (Narkwichian et. al, 2009).

Therefore, the more the food is processed the more it contains “nutrients of concern” namely, fat, trans fat, sodium and added sugar. These nutrients should be taken within the recommended limits. The excess intake of “nutrients of concern” may lead to chronic degenerative diseases which have been discussed as follows in section 2.3.

### **2.3. Processed Foods and Diet Related Non-Communicable Diseases (DR-NCDs)**

There are number of health risks associated with the consumption of processed foods. Unhealthy commodities like soft drinks and processed foods that are high in salt, fat and sugar are the leading risk factors for chronic non-communicable diseases (NCDs) (Stuckler et. al, 2012).

Unlike populations affected by hunger, populations affected by nutrition transition have diets adequate in energy, but the quality of the diet remain poor and often involves the intake of more energy than needed. Poor-quality diets are one of the leading risk factors for diet-related chronic diseases, like heart disease, diabetes, and some cancers, as well as overweight, obesity and hypertension. As a result, the prevalence of diet-related chronic diseases is rising in developing countries (Strong et. al, 2005). Developing countries, like India, China, Indonesia and Brazil, higher social classes, particularly with an increase in income and greater availability of ready prepared foods, have been observed to have higher risk of NCDs, cardiovascular diseases (CVDs) including coronary artery disease (CAD), stroke, hypertension and type-2 diabetes mellitus (Singh et. al, 2005; Singh et al, 2011b; Pednekat et. al, 2011).

Food can be a good source to predict the risk of chronic diseases. Quantification of nutrients of concern like saturated fat, trans fat, sodium and added sugar in diet can prove to be very useful in assessing the dietary impact of foods on health. NHANES 2003-2006 data from US diet surveys revealed top ten sources of added sugar as

“soft drink, soda”, “candy, sugars, sugary foods”, “cake, cookies, quick bread, pastry and pie”, “fruit drinks and ades”, “milk desserts”, “ready-to-eat cereal”, “yeast breads and rolls”, “milk drinks”, “yogurt” and “condiments and sauces.” Similarly top ten sources of saturated fats were “cheese”, “beef”, “milk”, “other fats and oils”, “frankfurters, sausages, luncheon meats”, “cake, cookies, quick bread, pastry, pie”, “margarine and butter”, “milk desserts”, “poultry” and “crackers, popcorn, pretzels, chips.” It was found that top 10 food sources of sugar accounted for 93% of added sugars and 68% of the total sugars in the U.S. diet. Sugar source “soft drinks, soda”, contributed one-third of the total daily intake by the population in US but they provide little or no nutritional value. The top 10 food sources of SFA represented three-fourths (73.6%) of SFA intake in the U.S. diet. Reducing intake of these foods in diet could reduce the energy intake and bring about healthy dietary modifications (Huth et. al, 2013).

Trans fats are ubiquitous in baked and processed foods and therefore, being targeted as a significant contributor to heart disease. The adverse effects related to chronic heart diseases (CHD) are mediated by increased plasma concentrations of low-density lipoprotein cholesterol (LDL-C) and lipoprotein(a) (Lp(a)) and reduction in high-density lipoprotein cholesterol (HDL-C), promotion of inflammation and endothelial dysfunction and possible effects on coagulation, insulin resistance and displacement of essential fatty acids from membranes, affecting prostanoid-related functions and possibly other key membrane-related functions. The current body of evidence further indicates that TFA enhances multiple cardiovascular risk factors and increases CHD-related events (WHO, 2003; Nishida et. al., 2004). Consumption of trans fatty acids raises levels of low-density lipoprotein (LDL) cholesterol levels, reduces levels of high-density lipoprotein (HDL) cholesterol and increases total cholesterol to HDL cholesterol ratio, a powerful predictor of the risk of CHD. Trans fats also increases the blood levels of triglycerides as compared with the intake of other fats, increases levels of Lp(a) lipoprotein and reduces the particle size of LDL cholesterol, each of which may further raise the risk of CHD (Mensink et. al, 2003). Recent evidence indicates that trans fats promote inflammation. In women, greater intake of trans fatty acids was associated with increased activity of the tumor necrosis factor (TNF) system, among those with a higher body-mass index, greater

intake of trans fatty acids was also associated with increased levels of interleukin-6 and C-reactive protein (Mozaffarian et.al, 2004).

Several studies suggested that trans fats cause endothelial dysfunction. After adjustment for other risk factors, greater intake of trans fatty acids was found to be associated with increased levels of several markers of endothelial dysfunction, including soluble intercellular adhesion molecule 1, soluble vascular- cell adhesion molecule 1 and E-selectin (Lopez-Garcia et. al, 2005). Trans fatty acids may influence other risk factors or cardiovascular disease. In controlled trials, consumption of trans fats reduced the activity of serum paraoxonase, 35 an enzyme that is closely associated with HDL cholesterol and impaired the postprandial activity of tissue plasminogen activator and probably insulin sensitivity (Muller et. al, 2001).

Several studies have pointed out that saturated fats and trans fats damage cardiovascular health while polyunsaturated fats, particularly marine omega-3 fatty acids are protective. Partially hydrogenated oils and TFAs are found in shortenings, margarines, industrial cooking oils and in processed foods such as fast foods, french fries, donuts, cookies, dry soup powders and pastries (Chong et. al, 2006).

A prospective epidemiological study has shown a consistent positive associations between sugar sweetened beverage (SSB) intake and weight gain and obesity in children and adults. SSBs lead to weight gain due to their high sugar content and incomplete compensation for total energy at subsequent meals after intake of liquid calories (Malik et. al, 2006). High intake of sugar sweetened beverages (SSB) may increase the risk of metabolic syndrome and type-2 diabetes by increasing obesity. SSBs also have high content of rapidly absorbable carbohydrates namely, sucrose (50% glucose and 50% fructose) and high-fructose corn syrup (most often 45% glucose and 55% fructose), which leads to increased dietary glycemic load thereby increasing insulin resistance, cell dysfunction and inflammation (Schulze et. al, 2004). A prospective study (19 months long) was carried out among 548 school children aged 7-11 years from four public schools in Massachusetts to determine the relationship between consumption of SSBs and prevalence of obesity. Findings suggested that for each additional serving of sugar-sweetened drink consumed, both body mass index (BMI) and frequency of obesity increased after adjustment for anthropometric, demographic, dietary, and lifestyle variables. Hence, the

consumption of sugar-sweetened drinks was found to be directly associated with increasing obesity rates among children (Ludwig et. al, 2001b).

A hospital based study in Tehran, Iran involving 100 female patients aged 30-65 years with breast cancer and 174 female hospital controls was conducted to find out the relationship between “healthy” and “unhealthy” dietary patterns and breast cancer risk. The results indicated that women with “healthy” dietary pattern (i.e. consumption of vegetables, fruits, low-fat dairy products, legumes, olive and vegetable oils, fish, condiments, organ meat, poultry, pickles, soya and whole grains) had 75% decreased risk of breast cancer as compared to the women with “unhealthy” dietary pattern (i.e. consumption of soft drinks, sugars, tea and coffee, french fries and potato chips, salt, sweets and desserts, hydrogenated fats, nuts, industrial juice, refined grains and red and processed meat) (Karimi et. al, 2013).

A study carried out in US to find the relationship between increasing portion sizes of food available in marketplace with obesity revealed that food portions available in take away establishments, food outlets and family restaurants have increased in size from 1970s, rose further in 1980s and from then the increase is parallel with the increasing body weights. Except slice white bread, all the other food items exceeded the standard portion sizes recommended by USDA and FDA. The largest excess was found in cookies (700%) followed by cooked pasta (480%), muffins (333%), steaks (224%) and bagels (195%) (Young and Nestle, 2002).

An investigation among 944 Korean adolescents (501 boys and 443 girls) revealed that their dietary pattern largely involved the consumption of flour, pizza, hamburgers, snacks and sweets which was associated with a higher prevalence of abdominal obesity, changes in plasma triacylglycerol (TAG) and glucose (Kim et. al, 2007). Another cross sectional study conducted in Rio De Janeiro, Brazil among 210 adolescents revealed that the higher average daily intakes of energy, carbohydrates and ultra-processed foods among adolescents was associated with Metabolic Syndrome (MetS) (Ferreira et. al, 2011). A study in Brazil discovered that the contribution of ultra-processed foods to the total energy among Brazilian families increased by more than 200% between 1974 and 2003 (Monteiro, 2009; Monteiro et. al, 2011).

A randomized controlled trial was conducted at a hospital in Beijing involving 166 subjects with mild to moderate hypercholesterolemia. Eighty five subjects were given 100 grams of instant oat cereal and the control group (n=81) was given 100 grams of wheat flour-based noodles everyday for 6 weeks. Results after 6 weeks of intervention revealed that dietary fiber intake was significantly increased in the “instant oat cereal” group as compared to the control group. The total LDL-cholesterol and waist circumference was significantly decreased in the “instant oat cereal” group and HDL-cholesterol was found to decrease significantly in the control group. Hence, instant oat cereal (high fiber content) had protective effect on body lipids as compared to wheat flour based noodles (Zhang et. al, 2012).

A study carried out among 448,568 participants from 10 European countries, concluded that the intake of processed meat (50 g/day) was associated with a 30% higher rate of cardiovascular disease (CVD) and cancer mortality as compared to intake of unprocessed red meat. The preservatives present in the processed food are leading risk factors for these morbidities (Micha et. al, 2013).

## **2.4. Food/ Nutrition Labeling**

Processed/packaged foods which are usually high in fat, trans fat, sodium and sugar should be consumed judiciously. To begin with, understanding of food/nutrition labeling is must to make healthy food choices by the consumers

Food/Nutrition labeling is the first and the most important source of information regarding the nutritional content of food purchased by the consumer (Grunert and Wills, 2007). It is a tool for nutrition education and information about essential components of the food which has public health implications in preventing and managing diet related conditions such as obesity, cardiovascular disease and diabetes (Curran, 2002). Without nutrition labeling it is difficult for the consumers to identify the nutritional content of packaged food.

Food/Nutrition labeling can be defined as the information related to ingredients and nutrients with other miscellaneous information like date of manufacture, best before date, batch/lot number etc. given on food labels. According to the Codex Alimentarius “Nutrition labeling is a description intended to inform the consumers of nutritional properties of a food”. “Labeling includes any written, printed or graphic matter that is

present on the label, accompanies the food or is displayed near the food, including that for the purpose of promoting its sale or disposal.” (Codex, Guidelines on Nutrition Labeling, CAC/GL 2-1985). Food/Nutrition labeling is a combination of various mandatory (Nutrition Facts Panel (NFP) and ingredients) and voluntary information (symbols and logos, nutrient claims, health claims, allergen declaration) on food labels. Mandatory information is compulsory to be printed on food labels while voluntary information declaration is optional for the manufacturers. However, if any voluntary claim is being made then it should be substantiated by NFP. For example, nutrient claim “sugar free” should be substantiated by reporting the sugar value as zero/nil on NFP. Food/Nutrition labeling is found on Front of Pack (FOP) and Back of Pack (BOP). FOP labeling is characterized by short, precise declaration about nutrients or ingredients in the form of nutrient and health claims while BOP labeling includes more detailed presentation of nutrients in the form of Ingredients list and NFP with other miscellaneous information like best before and expiry date, batch number, manufacturer’s address, etc. Symbols and logos, nutrient and health claims can be declared either on FOP or BOP or both.

#### **2.4.1. Principles of Food/Nutrition Labeling**

##### **a. Nutrient Declaration**

The information supplied through nutrient declaration should be such that it should give the correct information about the nutritional quality of the food (Codex, Guidelines on Nutrition Labeling, 1985).

##### **b. Supplementary Nutrition Information**

The content of supplementary nutrition information varies from one country to another and within any country from one target population group to another according to the educational policy of the country and the needs of the target groups (Codex, Guidelines on Nutrition Labeling, 1985).

##### **c. Nutrition Labeling**

Nutrition labeling should not deliberately imply that a food which carries such labeling has necessarily any nutritional advantage over a food which is not so labeled (Codex, Guidelines on Nutrition Labeling, 1985).

## 2.4.2. Components of Nutrition Labeling

**2.4.2.1 . Symbols and Logos:** According to Food Safety and Standards Act (FSSA) of India, it is mandatory to declare on the food package about its vegetarian or non-vegetarian origin with the help of symbols. The brown color filled circle inside a square of minimum specified size denotes “non-vegetarian food” while when it is green in color the product is vegetarian (FSSA, 2011). Any other symbols/logos beside these two are voluntary. Such symbols/logos are AGMARK, HACCP, FPO, Healthy Choice, Smart Choice, etc.

**2.4.2.2. Nutrient Claims:** “Nutrient claim means any representation which states, suggests or implies that a food has particular nutritional properties which are not limited to the energy value but include protein, fat carbohydrates, vitamins and minerals” (FSSA, 2011; Codex, 1985). Nutrient claim is usually related to the function, presence or absence of a nutrient in a food. For e.g. nutrient claims like “low in fat”, “good source of calcium”, “high in dietary fibre”, “zero cholesterol”, etc. Nutrient claims are not mandatory but if it is declared on the label then it becomes inevitable to have the nutrition value declared on the NFP. For e.g. when a claim “rich in iron” is made on the label then it is mandatory to have iron values as percentage/mg on the NFP and this is called substantiation of a claim (Curran, 2002).

**2.4.2.3. Health Claims:** “Health claims means any representation that states, suggests or implies that a relationship exists between a food or a constituent of that food and health and include nutrition claims which describe the physiological role of the nutrient in growth, development and normal functions of the body, other functional claims concerning specific beneficial effect of the consumption of food or its constituents, in the context of the total diet, on normal functions or biological activities of the body and such claims relate to a positive contribution to health or to the improvement of function or to modifying or preserving health or disease, risk reduction claim relating to the consumption of a food or food constituents, in the context of the total diet, to the reduced risk of

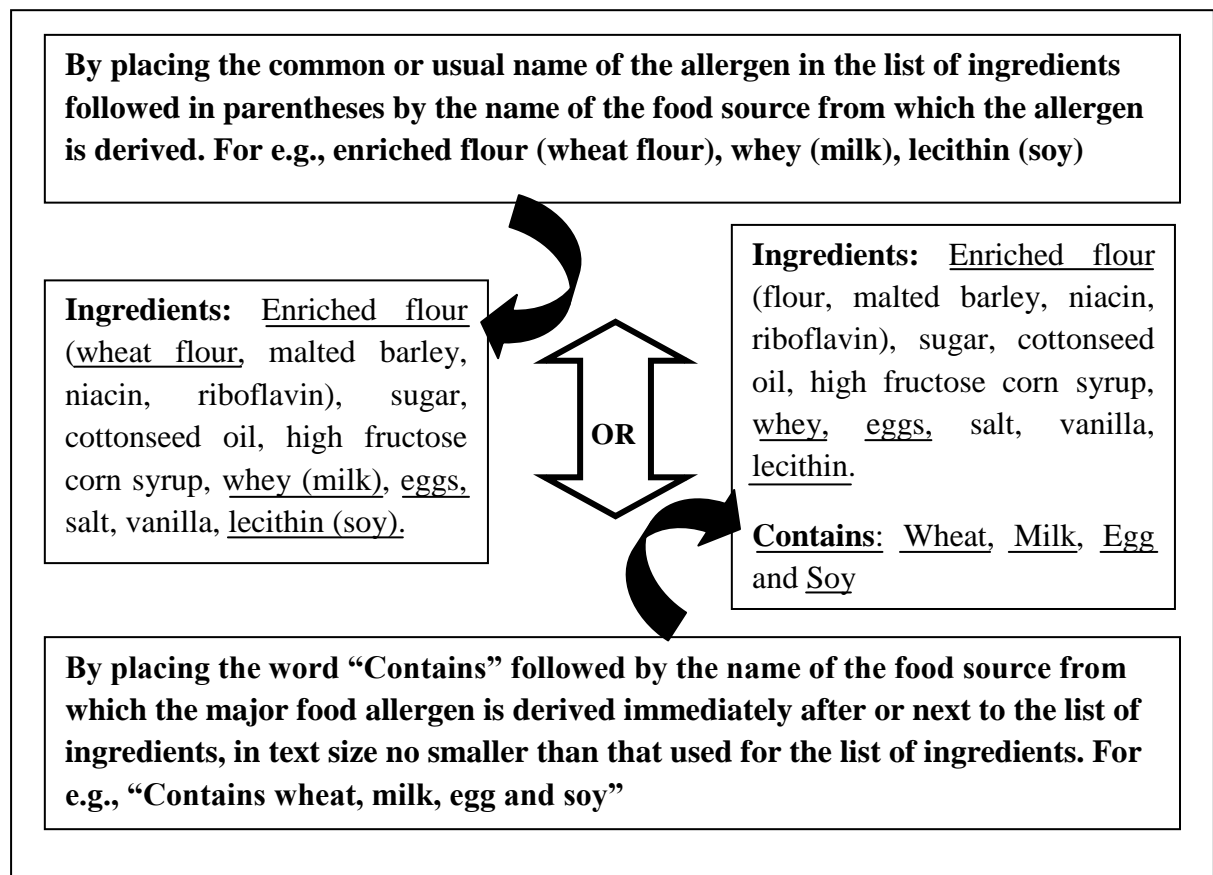
developing a disease or health related condition” (FSSA, 2011; Codex, 1985).

**2.4.2.4. Allergen Information:** Any product containing allergy causing ingredient should be declared on the food label. The most common allergy causing foods are cereals containing gluten, crustacean, peanut, tree nuts, egg, milk, fish, soy and sulphite in concentrations of 10 mg/kg or more (Codex, 2010; Boyce et. al, 2010; AAAAI, 2011). The United States Food and Drug Administration (USFDA) passed Food Allergy Labeling and Consumer Protection Act (FALCPA) in 2004 as an amendment to Federal Food, Drug and Cosmetic Act. FALCPA which became effective from January 1, 2006 applies to the packaged food products. The aim of the FALCPA is to make it easier for the consumers with food allergies and their caregivers to identify and avoid foods that contain major food allergens. According to FALCPA, if any food product found to contain an undeclared allergen can be summoned up or not properly labeled can be subjected to seizure and removed from the market place (<http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/allergens/ucm106890.htm>). However, such strict regulations have not been placed in India, except FSSA which states general labeling of allergy causing ingredients and advisory/precautionary statements.

According to the recent proposed guidelines by FALCPA, an allergen can be stated on the food labels in one of the two ways as follows,

1. By placing the word “Contains” followed by the name of the food source from which the major food allergen is derived immediately after or next to the list of ingredients, in text size no smaller than that used for the list of ingredients. For e.g., “Contains wheat and milk”.
2. By placing the common or usual name of the allergen in the list of ingredients followed in parentheses by the name of the food source from which the allergen is derived. For e.g., “lecithin (soy)” (<http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/allergens/ucm106890.htm>)



**Figure 2.6: Proposed Changes for Allergen Labeling by FALCPA**

Source: <http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/allergens/ucm106890.htm>

**2.4.2.5. Ingredients List:** Ingredients list is the information on the food labels which states the food composition of the package. The ingredients list shall be headed or preceded by an appropriate title which consists of or includes the term ‘ingredient’. All ingredients shall be listed in descending order of ingoing weight at the time of the manufacture of the food. Where an ingredient is itself the product of two or more ingredients, such a compound ingredient may be declared, as such, in the list of ingredients, provided that it is immediately accompanied by a list, in brackets, of its ingredients in descending order of proportion. Where a compound ingredient (for which a name has been established in a Codex standard or in national legislation) constitutes less than 5% of the food, the ingredients, other than food additives which serve a technological function in the finished product, need not be declared (Codex, 2010; FSSA, 2011).

**2.4.2.6. Nutrition Facts Panel (NFP):** Nutrition Facts Panel is a tabular presentation or declaration of the nutrients contained in a food package. Nutrition information on NFP is usually given as,

- “per 100g” or
- “per serving” or
- “%DV” or
- combination of “per 100g and per serving” or
- combination of “per serving and %DV” or
- combination of per 100g, per serving and %DV.”

According to Codex Alimentarius, NFP should have the following mandatory nutrients:

- Energy
- Protein
- Carbohydrate
- Fat
- Any other nutrient for which a nutrition or health claim is made (Codex, 1985).

In addition to the above nutrients, Indian food labeling laws also require “sugars” as mandatory nutrient to be declared on the NFP (FSSA, 2011).

**2.4.2.7. Preservatives:** "Preservative" means a substance which when added to food, is capable of inhibiting, retarding or arresting the process of fermentation, acidification or other decomposition of food. Preservatives are classified as Class I preservatives and Class II preservatives. Use of more than one Class II preservative is prohibited (FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

**2.4.2.8. Food Additives:** Food additives have been classified in various groups. Only permitted food additives can be used in a processed packaged food. However, they should always be declared with their specific names or recognized international numerical identifications as given by FSSA. The following class titles shall be used together with the specific international numerical identifications:

Acidity Regulator, Acids, Anticaking Agent, Antifoaming Agent, Antioxidant, Bulking Agent, Colour, Colour Retention Agent, Emulsifier, Emulsifying Salt, Firming Agent, Flour Treatment Agent, Flavour Enhancer, Foaming Agent, Gelling Agent, Glazing Agent, Humectant, Preservative, Propellant, Raising Agent, Stabilizer, Sweetener, Thickener (FSSAI, Packaging and Labeling Regulations, 2011; FSSAI, Food Products Standards and Food Additives, 2011).

#### 2.4.2.9. Colors and Flavors

- **Colors:** When any extraneous color is added to a food, it should be mentioned on the food label just below the list of ingredients. It should be specifically stated as below:

CONTAINS PERMITTED NATURAL COLOUR(S)

OR

CONTAINS PERMITTED SYNTHETIC FOOD COLOUR(S)

OR

CONTAINS PERMITTED NATURAL AND SYNTHETIC FOOD COLOUR(S)

- **Flavors:** When any extraneous flavor is added to a food, it should be mentioned on the food label just below the list of ingredients. It should be specifically stated as below:

CONTAINS ADDED FLAVOUR- NATURAL FLAVORING SUBSTANCES

OR

CONTAINS ADDED FLAVOUR- NATURE-IDENTICAL FLAVORING SUBSTANCES

OR

CONTAINS ADDED FLAVOUR- ARTIFICIAL FLAVOURING SUBSTANCES

- In case both color and flavor are used in the product, one of the following combined statements in capital letters shall be displayed, just beneath the list of ingredients on the label attached to any package of food so colored and flavored, namely,

CONTAINS PERMITTED NATURAL COLOUR(S) AND ADDED FLAVOUR(S)

OR

CONTAINS PERMITTED SYNTHETIC FOOD COLOUR(S) AND ADDED  
FLAVOUR(S)  
OR  
CONTAINS PERMITTED NATURAL AND SYNTHETIC FOOD COLOUR(S) AND  
ADDED FLAVOUR(S)

(FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

**2.4.2.10. Date of Manufacture:** “Date of manufacture” means the date on which the food becomes the product (FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

**2.4.2.11. Date of Packaging:** “Date of packaging” means the date on which the food is placed in the immediate container in which it will be ultimately sold (FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

**2.4.2.12. Best Before Date and Expiry date:** There is very fine line between “Best before” and “Expiry” date of the food product. “Best before” date is the date after which the food product is not advisable to be marketed however it may still be safe to consume but its quality may have diminished. On the other hand, “Expiry” date of the product signifies the date after which the food product’s quality and safety attributes diminishes to a level that it cannot be consumed by the consumer. “Expiry date” is also termed as “Use-by date” or “Recommended last consumption date” (FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

Following are the formats according to which Best Before and Use By Date should be labeled:

“BEST BEFORE ..... MONTHS AND YEAR  
OR  
“BEST BEFORE ..... MONTHS FROM PACKAGING  
OR  
“BEST BEFORE .....MONTHS FROM MANUFACTURE

**2.4.2.13. Batch number:** Batch number signifies a lot/group of the food products manufactured at a time under similar manufacturing conditions. It is usually denoted by numbers or alphabets or a combination of both. It is also termed as “Lot number” or “code number” and usually found at the BOP with the prefix “Lot No” or “Lot” or “code number” or “Code” or Batch No” or “Batch.” It helps in tracing the food product when required (FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

**2.4.2.14. Net quantity:** Net quantity is mandatory to be labeled on every packaged food. It can be declared by weight or volume or number, as the case may be. However, a food packed in a liquid medium shall carry a declaration of the drained weight of the food (FSSA, Packaging and Labeling Regulations, 2011; FSSA, Food Products Standards and Food Additives, 2011).

## **2.5. Food Regulations**

Through decades, governments around the world have made efforts to provide food safety to its citizens by formulating and implementing various laws related to food. Earlier, the major concern of the states was to protect the consumers from adulterated foods. However, due to dietary shifts and increasing consumption of processed foods over the past few decades, it had become imperative for the law makers to formulate food laws related to food labeling in order to protect consumers against fraudulent food products. Parallel to this, there is also an aroused consumer interest for getting information about the food they consume. This has led to the development of “Food/Nutrition Labeling Laws/Regulations” by various countries around the globe. Internationally, “Codex Alimentarius” formulate food related guidelines and based on that several member countries develop their own food regulations which may vary according to the demography, dietary and cultural pattern of the region. The Codex Guidelines on Food/Nutrition Labeling play an important role to provide guidance to member countries when they want to develop or update their national regulations and to encourage the harmonization of national standards with international guidelines (Shimizu, 2002).

Food labeling guidelines are the guiding principles for the consumers, manufacturers, law makers and other stakeholders to understand and abide by the food laws. Food

Labeling Guidelines are generally based on the principle that no food should be described or presented in a manner that is false, misleading or deceptive. The guidelines include definition of the terms related to food and nutrition labeling, provision for mandatory and voluntary nutrition declaration, calculation and presentation of other nutrition information. The guidelines related to various claims (nutrient claims, comparative claims, health claims and allergy claims) establish general principles to be followed but the definition and specifications depend on the national regulations. Definitions are provided for claims as well as general requirements concerning consumer information. The purpose of nutrition labeling guidelines being laid down by Codex Alimentarius is to ensure that nutrition labeling is effective,

- In providing the consumer with information about the food so that an informed food choice can be made.
- As a tool for conveying nutrition information about the food purchased.
- As a motivation for the manufacturers to formulate healthy food products.
- In providing the opportunity to the manufacturers to include supplementary nutrition information on the label.
- To ensure that nutrition labeling does not describe a product or present information which is in any way false, misleading, deceptive or insignificant in any manner.
- To ensure that no nutrient claims are made without specific nutrient benefit (Codex, Guidelines on Nutrition Labeling, 1985).

### **2.5.1. Food Labeling Regulations in Developed Countries**

#### **2.5.1.1. International Food Regulations: Codex Alimentarius Commission**

The Codex Alimentarius Commission (CAC) was established in 1962 as a Joint Food and Agricultural Organization (FAO/WHO) inter-governmental body. It was established with the objectives to protect consumer's health and facilitate international trade in food through harmonization of food standards on a worldwide basis. Codex standards, codes and related texts have received wider acknowledgement following the conclusion of the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT), as Codex was specifically mentioned under SPS while reference to international standards applies to Codex in the framework of TBT (Van den Wijngaart, 2002). Following are various food related regulations established by Codex:

- General Standard for the Labeling of Prepackaged Foods (Codex Stan 1-1985)
- Guidelines for Use of Nutrition and Health Claims (CAC/GL 23-1997)
- Guidelines on Nutrition Labeling (CAC/GL 2-1985)
- General Standard for the Labeling of Food Additives when sold as such (CODEX STAN 107-1981)
- General Standard for the Labeling of Claims for Prepackaged Foods for Special Dietary Uses (CODEX STAN 146-1985)
- General Guidelines on Claims (CAC/GL 1-1979)
- General Guidelines for Use of the term “Halal” (CAC/GL 24-1997)
- Codex Standard for Edible Fats and Oils not Covered by Individual Standards (CODEX STAN 19-1981)
- Codex Standard for Special Dietary Foods with Low-Sodium Content (Including Salt Substitutes) (CODEX STAN 53-1981)
- Codex Standard for Processed Cereal-based Foods for Infants and Young Children (CODEX STAN 074-1981, REV. 1-2006)
- Codex Standard for the Labeling of and Claims for Foods for Special Medical Purposes (CODEX STAN 180-1991)
- Codex General Standard for Food Additives (CODEX STAN 192-1995)
- Codex Standard for Named Vegetable Oils (CODEX STAN 210-1999)
- Codex Standard for Sugars (CODEX STAN 212-1999)
- Codex Standard for Dairy Fat Spreads (CODEX STAN 253-2006)
- Codex Standard for Fat Spreads and Blended Spreads (CODEX STAN 256-2007 )

#### **2.5.1.2. Canada**

Canada has the following food regulations related to processed packaged foods,

- Consumer Packaging and Labeling Regulations by Canadian Food Inspection Agency (C.R.C., c. 417- July 10, 2013).
- Processed Products Regulations (C.R.C., c. 291- July 10, 2013).

According to Canadian food regulations,

- “Processed” means, in respect to food product, canned, cooked, frozen, concentrated, pickled or otherwise prepared to assure preservation of the food product in transport, distribution and storage, but does not include the final cooking or preparation of a food product for use as a meal or part of a meal such as may be

done by restaurants, hospitals, food centres, catering establishments, central kitchens or similar establishments where food products are prepared for consumption rather than for extended preservation.

- “Prepackaged product” means any product that is packaged in a container in such a manner that it is ordinarily sold to or used or purchased by a consumer without being re-packaged.
- “Label” means any printed, stencilled, lithographed or embossed label, sticker, seal, wrapper, stencil or receptacle.
- “Ingredient” means an individual unit of food that is combined with one or more other individual units of food to form an integral unit of food (Processed Food Regulations, Canada, 2013).

In Canada, a standardized "Nutrition Facts" label was introduced as part of regulations passed in 2003 and became mandatory for most pre-packaged food products on December 12, 2005. Canadian regulation closely monitors the format in which Nutrition Facts Table (NFT) is reported on food package. There are about 28 main formats and 2 to 7 sub formats for each main formats of NFT. The NFTs can be vertical, horizontal or linear. Of the three, vertical format is the most preferred one and commonly used on the food labels (<http://www.hc-sc.gc.ca/fn-an/label-etiquet/nutrition/reg/index-eng.php>).

### **2.5.1.3. European Union**

European Union (EU) is regulated by the Commission Directive 2008/100/EC of 28<sup>th</sup> October, 2008 amending Council Directive 90/496/EEC on nutrition labeling for foodstuffs. The EU is responsible to lay down the definitions, recommended daily allowances (RDA) and energy conversion factors for food labeling. In the European Union, the information (usually in panel format) is usually labeled as "Nutrition Information". The panel is optional however it should be displayed in prescribed format. It usually report nutrients as per 100 gram of the product, however it can also have the nutrient information as “per serving” of the product ([http://europa.eu/legislation\\_summaries/consumers/product\\_labelling\\_and\\_packaging/l21092\\_en.htm](http://europa.eu/legislation_summaries/consumers/product_labelling_and_packaging/l21092_en.htm)).



#### **2.5.1.4. United Kingdom (UK)**

Food Standards Agency (FSA) is the single authority responsible for formulating food laws and regulations related to food labeling. It is an advisory body to the government on the need for legislation on all aspects of food safety and standards. The agency obtains advice from independent scientific advisory committees and also commission research and surveillance (Rabo India Finance Pvt. Ltd, 2005).

#### **2.5.1.5. United States of America (USA)**

The US Nutrition Labeling and Education Act (NLEA) of 1990 standardized the provision of nutrition information in the United States and led to the creation of nutrition facts panels found on all manufactured food items. Since the implementation of NLEA, shoppers have been provided an increasing amount of alternative nutrition labels by manufacturers, grocery stores and other interested parties. For example, Kraft Foods uses its Sensible Solution label for healthier food items, while the American Heart Association uses a heart-check mark label for foods that are good for heart (Berning et. al, 2010).

### **2.5.2. Food Labeling Regulations in Developing Countries**

#### **2.5.2.1. Bangladesh: Bangladesh Labeling Requirements for Packaged Food 2013**

There is no separate law regulating the labeling requirements for food and agricultural commodities in Bangladesh. The labeling of domestically produced and packaged condensed milk and dried milk powder are prescribed in Bangladesh's Pure Food Rules (1967) promulgated by the Department of Health. The government was granted the power to implement these rules via the Bangladesh Pure Food Ordinance of 1959. Although these rules details the provision on food poisoning, food coloring, preservatives in food, etc., but there is no reference for the labeling requirements related to packaged food items, except for condensed milk and dried milk powder. The ordinance was amended in 2005 and renamed as "The Bangladesh Pure Food (Amendment) Act 2005." The amendments included only revisions of some definitions and financial penalty enhancements for offenses however labeling was not mentioned in the amendments. Currently, the main legal instrument that regulates the labeling requirements of imported food products is the Import Policy Order 2009-12. In light of requirements in the WTO Agreement on Technical Barriers to Trade (TBT) and the Agreement on the Application of Sanitary and Phytosanitary

(SPS) Measures, the Product Labeling Policy was introduced in 2006 to ensure that no barriers are created for the import and export of goods and to ensure that imported products have proper labels. The policy refers explicitly to international labeling standards to be observed in 15 sectors. Bangladeshi regulations stipulate that all imported food products must be labeled to indicate the manufacturer's name, complete address and country of origin, quantity or weight, ingredients/composition, code number, batch number and manufacture date and expiry date. Labeling may be in English or Bangla (Bengali) language. The Product Labeling Policy 2006 is not a regulation enacted by the government, however it is a policy undertaken by the government with initiative from the Bangladesh Standards and Testing Institution. The policy further indicates additional directives with regard to the preservation procedure, method of use and a precautionary statement on the label of the packaged food item. The following additional labeling requirements are applicable for agricultural commodities, food, drinks and soft drinks:

- The expiry date/best before date.
- The names and amount of color and preservatives used.
- Mention if the item is genetically modified (GM).
- If an item can be produced naturally, artificially or by genetic modification, the label is required to mention the method by which the item was produced.

If there is not enough space available on the label, additional printed paper containing the required information may be put into the labeling packet (Hussain, 2013).

#### **2.5.2.2. China**

On October 12, 2011, China's Ministry of Health released the National Food Safety Standard for Nutrition Labeling of Prepackaged Foods (GB 28050-2011). The standard prescribes the basic principles and requirements for the nutrition labeling and claims on pre-packaged foods directly offered to consumers. The standard also applies to the description and explanation of nutrition information on labels of pre-packaged foods. China notified the draft standard to the WTO as G/TBT/N/CHN/734 on April 21, 2010. Mandatory yet simple NFP include energy and core nutrients namely, protein, fat, carbohydrate and sodium. In all there are six standardized

formats for NFP and of which any can be used by the manufacturers to display nutrients on the food label (Meador and Jie, 2013).

#### **2.5.2.3. Malaysia**

##### **Laws of Malaysia Act 281 Food Act 1983**

This Act may be cited as the Food Act 1983 and shall apply throughout Malaysia. According to the Act, "Food" includes every article manufactured, sold or represented for use as food or drink for human consumption or which enters into or is used in the composition, preparation and preservation of any food or drink and includes confectionery, chewing substances and any ingredient of such food, drink, confectionery or chewing substances. "Label" includes any tag, brand, mark, pictorial or other descriptive matter, written, printed, stencilled, marked, painted, embossed or impressed on or attached to or included in belonging to or accompanying any food (Laws of Malaysia- Act 281, 2006).

#### **2.5.2.4. Japan**

The safety aspect is considered as the most important characteristic of all food products in Japan and because of this food industry and government are sparing no effort in ensuring food safety in all its products. In the 1950s, the Japanese industry was first introduced to Total Quality Control (TQC), termed as Total Quality Management (TQM) in the U.S.A. Since then, the TQC system has progressively spread throughout the industry including food processing. The Japanese industry introduced the ISO system in the 1980s and about 20,000 factories have been certified with ISO-9000 since then. The number of ISO-certified food manufacturing firms is steadily increasing every year. Hazard Analysis and Critical Control Point (HACCP) was introduced in Japan in the early 1990s and the Food Sanitation Law officially adopted the HACCP certification system as a comprehensive sanitation controlled manufacturing process in 1995. So far, several organizations issued certifications as a part of registration of ISO-9000 or individually for HACCP (Raju, 2002).

#### **2.5.2.4. Srilanka**

##### **Food Standards under the Food Act No: 26 of 1980**

Food is regulated in Sri Lanka by the Food Act. No: 26 of 1980 (amended in 1990) under the Ministry of Healthcare and Nutrition. The food standards issued as

regulations gazetted under this Act are mandatory, i.e. they have to be complied with by anyone manufacturing, importing, distributing or selling food in Sri Lanka. These standards, covering many products and processes are revised by the Food Advisory Committee of the Ministry of Healthcare and Nutrition and gazetted regularly when they become law. Food standards under the Food Act are used by food inspectors, food and drugs inspectors and public health inspectors throughout the island to implement the food control system in the country in order to ensure the food safety. Failure to comply with these requirements prompts legal action by the government. These Authorized Officers fall mainly under the purview of the Provincial Administration who carry out inspections of food processing factories, food retail outlets and even hotels and restaurants to ensure compliance with the law. Analysis of samples of foods seized by them is done either by the laboratories of the Government Analyst's Department, the Medical Research Institute or the laboratories under the Health Ministry located in Kaluthara and Anuradhapura ([http://thakshana.nsf.ac.lk/pdf%5CVIDURAWA%5CVIDU24\(2\)%5CVIDU-24\(2\)-6.pdf](http://thakshana.nsf.ac.lk/pdf%5CVIDURAWA%5CVIDU24(2)%5CVIDU-24(2)-6.pdf)).

#### **2.5.2.5. India**

##### **Food Safety and Standards Act (FSSA), 2006**

Till the year 2005, thirteen different laws were applicable on the food and food processing sector. Multiple laws/regulations recommended standards regarding food additives, contaminants, food colors and preservatives and labeling. In order to rationalize the multiplicity of food laws, a group of ministers (GoM) was set up to suggest legislative and other changes to formulate an integrated food law, to be a single reference point in relation to regulation of food products. Based on recommendation of the GoM, the Ministry of Food Processing enacted the Food Safety and Standards Act (FSSA) in 2006. Salient features of the act are:

- Several scientific panels and a central advisory committee together laid down standards for the safety. These standards included specifications for ingredients, contaminants, pesticide residue, biological hazards and labels.
- The law was enforced through state commissioners of food safety and local level officials.
- Everyone in the food sector is required to get a license or a registration which would be issued by the local authorities.

- Every distributor is required to be able to identify any food article to its manufacturer and every seller to its distributor. Anyone in the sector should be able to initiate recall procedures if he finds that the food sold had violated specified standards (Food Processing Sector in India, 2012).

## 2.6. Nutrition Labeling Schemes Worldwide

Different labeling schemes have been introduced by various countries around the globe to facilitate better understanding of nutrition labels among the consumers. The main objective of food labeling schemes is to present the nutrition information in the simplest form so as the consumers can select a healthier option in less time. Such schemes have one thing in common that they need minimum or no calculation skills which makes them simpler. Nutrition information on food labels can be classified on the basis of their complexity and location. According to location on the food package, nutrition labeling can be termed as Front of Pack (FOP) labeling and back of pack (BOP) labeling. BOP labeling is usually mandatory, detailed and complex while FOP is usually voluntary, to the point and simpler. BOP labeling compliments FOP labeling by providing the detailed information which is put up on FOP (Feunekes et. al, 2008; Bozhinov and Chrysochou, 2012).

Studies have shown that Nutrition Facts Panel which is found at the BOP is difficult to understand by the consumers and they find it confusing with regard to terminology and numerical information (Cowburn and Stockley, 2005). Due to this, consumers do not prefer BOP labeling as it is time consuming (Grunert and Wills, 2007). Compared to BOP, FOP labeling is easy to understand which helps in comparing products quickly (Kleef et. al, 2007). Therefore, labeling schemes mainly focuses on FOP labeling. FOP labeling differ from country to country. For example, the “Healthier choice tick”, “Health protection factor”, “Guiding Stars”, “Smileys”, “Guideline Daily Amounts (GDA)” and “Wheel of Health” are developed and introduced in European nations while “Smart Spot” is prevalent in the United States, “Shop Smart With Heart” is for Canada, “Pick The Tick” belongs to Australia and New Zealand and “Keyhole” is a trademark of Sweden and also followed in Denmark and Norway (Feunekes et. al, 2008).

### 2.6.1. Front of Pack Labeling Models Developed and Adopted By Various Countries

#### 2.6.1.1. Keyhole Nutrition Labeling (introduced in 1989)



**Figure 2.7: Keyhole symbol**

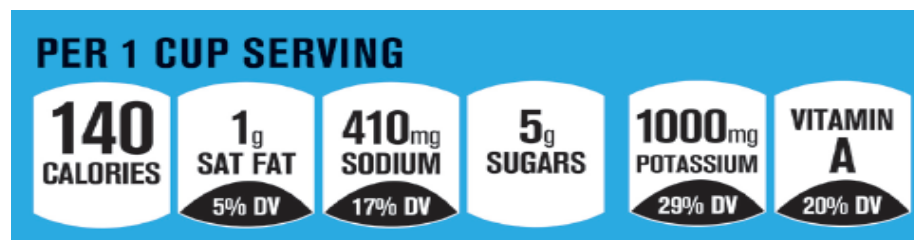
The keyhole is a simple, front-of-pack, voluntary symbol which is used on pre-packaged processed foods (Bozhinov and Chrysochou, 2012). It is a quick and effective tool to purchase a healthy product. The symbol was first introduced in Sweden in 1989. Due to the similarities in purchasing and consumption pattern of the population of Nordic countries (Sweden, Denmark and Norway), the symbol was later introduced in Denmark and Norway in June 2009. The Keyhole symbol on food products signifies that the product is relatively healthier in a sense that the product contain less fat, sugars and salt and more dietary fibre than the corresponding products not carrying the symbol in a particular food category. The Keyhole symbol does not include food products and food groups that are high in energy and/or low in nutrient value like soft drinks, candies, cakes, foods containing artificial sweeteners, etc. The Swedish National Food Administration has registered the keyhole as a trademark and the manufacturers using the symbol are bound to fulfill the criteria according to the regulation.

The objective of introducing keyhole symbol was to assist the consumers in making healthier food choices without involving much time and to motivate manufactures to develop healthier food products and to reformulate existing products.

#### **Advantages of Keyhole symbol:**

- It is easy to understand by the consumers.
- It requires minimal pre-existing knowledge about nutrition.
- It does not require language skills.
- It is used on food products that are important in a healthy diet.
- It is accepted by the food manufacturing industry (Norwegian Food Safety Authority, 2010).

### 2.6.1.2. Facts Up Front



**Figure 2.8: Facts-up-Front Labeling**

Facts-Up-Front is a voluntary label introduced in US. Facts-Up-Front takes the most important information from the Nutrition Facts Panel and places it on the front of the package, allowing consumers to access the information they need quickly and easily.

- Facts-Up-Front shows calories per serving and information on three nutrients to limit in the diet namely, saturated fat, sodium and sugar.
- Facts-Up-Front labels may also have information on one or two nutrients that should be consumed as part of a healthy diet. These “encouraged” nutrients appear on a package only if the product contains 10% or more of the daily value per serving of the nutrient and meets the FDA requirements for a “good source” ([www.FactsUpFront.org](http://www.FactsUpFront.org)).

### 2.6.1.3. Traffic Light Signposting



**Figure 2.9: Traffic light labeling system recommended by Food Standards Agency**

Food Standards Agency of United Kingdom developed “Traffic Light Signposting” scheme for FOP labeling. This scheme took over the other FOP schemes as it included colors to depict nutrients as high, medium or low. Red, amber and green color represented high, medium and low level of nutrients, respectively. The color

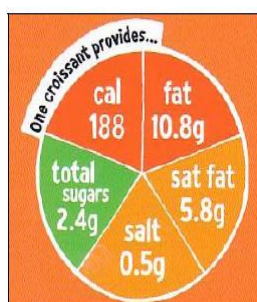
coded nutrition information can be easily understood by people with low level of education and comprehension skills. Only the key nutrients like fat, saturated fat, sugars and salt are presented in color codes on FOP (FSA, 2007).

**Table 2.4: Criteria used in the Color-coded Traffic Light System for Classifying Nutrients as Low (Green), Medium (Amber) or High (Red)**

Key Nutrients	Type of Food	Green (Low)	Amber (Medium)	Red (High)	
Total Fat	Solids	$\leq 3.0\text{g}/100\text{g}$	$>3.0$ to $\leq 20.0\text{g}/100\text{g}$	$>20.0\text{g}/100\text{g}$	$>21.0\text{g}/\text{portion}$
	Liquids	$\leq 1.5\text{g}/100\text{ml}$	$>1.5$ to $\leq 10.0\text{g}/100\text{ml}$	$>10.0\text{g}/100\text{ml}$	
Saturated Fat	Solids	$\leq 1.5\text{g}/100\text{g}$	$>1.5$ to $\leq 5.0\text{g}/100\text{g}$	$>5.0\text{g}/100\text{g}$	$>6.0\text{g}/\text{portion}$
	Liquids	$\leq 0.75\text{g}/100\text{ml}$	$> 0.75$ to $\leq 2.5\text{g}/100\text{ml}$	$>2.5\text{g}/100\text{ml}$	
Sugars	Solids	$\leq 5.0\text{g}/100\text{g}$	$>5.0$ to $\leq 12.5\text{g}/100\text{g}$	$>12.5\text{g}/100\text{g}$	$>15.0\text{g}/\text{portion}$
	Liquids	$\leq 2.5\text{g}/100\text{ml}$	$> 2.5$ to $\leq 7.5\text{g}/100\text{ml}$	$>7.5\text{g}/100\text{ml}$	
Salt	Solids	$\leq 0.3\text{g}/100\text{g}$	$>0.3$ to $\leq 1.5\text{g}/100\text{g}$	$>1.5\text{g}/100\text{g}$	$>2.4\text{g}/\text{portion}$
	Liquids	$\leq 0.3\text{g}/100\text{ml}$	$> 0.3$ to $\leq 1.5\text{g}/100\text{ml}$	$>1.5\text{g}/100\text{ml}$	

Source: Louie et. al, 2008

**Figure 2.10: Variants of Traffic light signposting used by various manufacturers in UK**



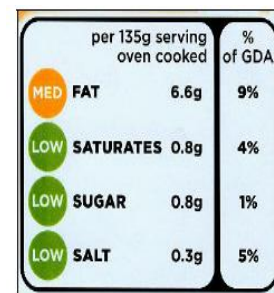
**Figure 2.10 (a)**



**Figure 2.10 (b)**



**Figure 2.10 (c)**



**Figure 2.10 (d)**

Key:

Figure 2.10 (a): Sainsbury's "Wheel of Health" color coded scheme (on Sainsbury's products)

Figure 2.10 (b): Waitrose's Traffic Light Labeling Scheme (Waitrose's sandwiches etc.)

Figure 2.10 (c): Traffic light labeling on New Covent Garden Food Company's Soups

Figure 2.10 (d): McCain's Traffic Light Labeling Scheme (combination of GDA and Traffic light labeling on McCain's Original Oven Chips)



### 2.6.1.4. Guideline Daily Amount (GDA) Labeling Scheme



**Figure 2.11(a): Commonly Adopted GDA labeling**



**Figure 2.11(b): Color coded GDA labeling**

Guideline Daily Amounts (GDAs) labeling scheme was started in 1996 as Daily Guideline Intakes (DGI) by UK Ministry of Agriculture Fisheries and Food (MAFF) (now Food Standards Agency (FSA)). Initially GDA was laid down for fat, saturated fat, sodium, sugar and fibre in grams per day for men and women. In 1998, Institute of Grocery Distribution (IGD) set values for calories, fat and saturated fat based on recommendations of 1991 Committee on Medical Aspects of Food Policy (COMA) report. In 2005, the IGD reviewed and extended the GDAs which resulted in development of consistent back-of-pack GDA scheme for adult males and females and for children in four age groups. With the release of GDA values by IGD, many supermarkets in UK started to display GDAs for calories, sugars, fat, saturated fat and salt on BOP. In 2005, Tesco (largest UK retailer) started displaying GDA nutritional signposting on the front of pack. It was soon followed by several food manufacturers and other retailers. In 2006, Food and Drink Federation (FDF) took initiatives for development of consistent front of pack GDA labeling. In January 2007, a campaign called “Know What's Going Inside You” was launched to raise awareness among consumers about the usage of front of pack GDA labeling scheme (<http://www.gdalabel.org.uk/gda/home.aspx>).

In Australia too, the Australian Food and Grocery Council (AFGC) promote GDAs to local manufacturers. The AFGC have also developed a leaflet to support companies wishing to implement GDA scheme. In December 2011 the new EU Regulation 1169/2011 on Food information to consumers came into force and allowed the continuation of the use of GDAs per portion indications on a voluntary basis on both FOP and BOP. The new regulation also introduced EU Reference Intake values for energy, total fat, saturates, carbohydrates, sugars, protein and salt. When displayed on the FOP, %GDAs can only be given for either energy alone or energy together

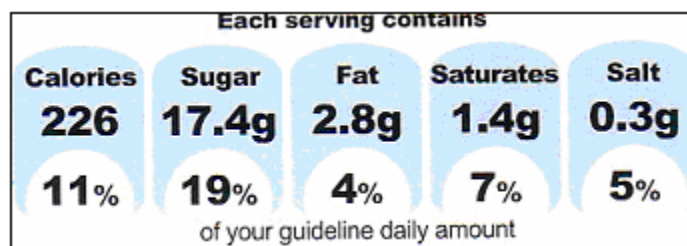
with the amounts of fat, saturates, sugars and salt. The new rules on nutrition labeling were made compulsory in December 2014 for companies already displaying nutrition information and companies that do not display nutrition information have to abide by new rules by December 2016 (<http://www.gdalabel.org.uk/gda/explained.aspx>).

GDAs are the total or one hundred per cent (100%) of the recommended calories and the recommended maximum amounts of sugars, fat, saturates (saturated fat) and salt that an average adult should eat in one day. The recommended GDAs for various nutrients have been presented in Table 2.5.

**Table 2.5: Recommended GDAs for Various Nutrients**

Guideline Daily Amount Values			
Typical values	Women	Men	Children (5-10 years)
<b>Calories</b>	2,000 kcal	2,500 kcal	1,800 kcal
<b>Protein</b>	45 g	55 g	24 g
<b>Carbohydrate</b>	230 g	300g	220 g
<b>Sugars</b>	90 g	120 g	85 g
<b>Fat</b>	70 g	95 g	70 g
<b>Saturates</b>	20 g	30 g	20 g
<b>Fibre</b>	24 g	24 g	15 g
<b>Salt</b>	6 g	6 g	4 g

**Figure 2.12: Understanding GDAs**



- The top line of text on the label shows the amount of food for which the information is being displayed (for e.g., the information can be for “each serving”, “each slice”, “per 50g portion” etc).
- Next line provides information about each nutrient. Usually, GDA labels contain five nutrients in the order namely, calories, sugars, fat, saturates (saturated fat) and salt .

- c. Next line after nutrients, gives the amount of nutrients each serving or portion or pack contains. For e.g. in the figure 2.12 one serving is providing 226 Kcal, 17.4g sugar, 2.8g fat, 1.4g saturated fat and 0.3g salt. The calorie GDA for an adult is 2,000 Kcal. Consuming 226 Kcal from this product means that a person has consumed 11% of the total 2,000 Kcal and now left with 89% Kcal for the day out of 100% calories. Similarly, 17.4g sugar means 19% GDA of the sugar consumed through this product.

In-store interviews (n=2,019) at three major UK retail outlets discovered that the main sources of information on food labels mentioned by the respondents were the GDA label, the nutrition grid and the traffic light label. Of these three, GDA label was reported to be the most widely used by the consumers (Grunert et. al, 2010). Another study in six European countries (namely, UK, Sweden, France, Germany, Poland and Hungary) revealed that 50% of the respondents from UK, Sweden and Germany knew the exact meaning of GDA labeling and it was lowest in France. The interpretation of GDA reference value of 70g for fat was highest in UK (88.6%) and lowest in France (42%) (Grunert et al, 2010b).

#### 2.6.1.5. Pick the Tick Program



**Figure 2.13: National Heart Foundation Symbol**

The National Heart Foundation of New Zealand (NHF) introduced front-of-pack “Pick the Tick” nutrition labeling programme in 1991. Only those food products that meet the defined nutritional criteria related to standardized levels of total fat, saturated fat, trans fatty acids (for margarine only), sodium, added sugar, fibre and calcium (for soya milk only) can carry this symbol. To display the symbol on the products, the manufacturers have to enter a formal licensing agreement and their products should have the nutritional composition set by NHF. Before giving license, food products are also analyzed at an independent accredited laboratory and if the products do not

meet the criteria, companies are encouraged to reformulate the product in order to obtain the symbol (Young and Swinburn, 2002). Once a food product obtains “Pick the Tick” symbol they are routinely tested to ensure that they continue to meet the criteria (<http://www.heartfoundation.org.nz/healthy-living/healthy-eating/heart-foundation-tick/what-is-the-tick>). In Australia, National Heart Foundation issues the Heart Foundation Tick as a stamp of approval on margarines containing less than 1% TFA (Chong et. al, 2006).

#### **2.6.1.6. Healthy Choice Program**

The Choices Program is a global, front-of-pack food labeling program developed to help consumers to make healthy food choices. It was introduced in Netherlands in 2006 as a response to the World Health Organization’s call for food industry to take an active part in developing and reformulating food products according to the set international dietary guidelines to curb down the rising obesity and diet-related diseases around the world. Food products which contain the recommended levels of fat, sugar, salt and fibre can carry the Choices logo on FOP. This logo helps consumers in quick identification of a healthy product. The Choices logo is currently found on approximately 7,000 food and beverage products of more than 120 companies and the number is expected to grow even more (<http://www.choicesprogramme.org>). A study was conducted in Netherlands among 47 food manufacturing companies to investigate the effect of Choices logo on the development of healthier products by food manufacturers. A total of 417 products were found to comply with the Choices criteria, 168 products required reformulation while 236 products were newly developed to comply with the Choices criteria. Most of the products that were high in sodium (processed meats, sandwiches, soups and sandwich fillings) were reformulated. Dietary fiber was significantly higher in newly developed Choices product groups when compared with reference products, namely in fruit juices, processed meats, dairy products, sandwiches and soups. Therefore, the Choices logo had influenced food manufacturers to reformulate the products and develop new products with a healthier product composition, especially where sodium and dietary fiber are concerned (Vyth et. al, 2010).

### 2.6.1.7. Smart Choice Food Program



**Figure 2.14: Smart Choice Symbol**

In the United States, a group of food companies introduced the Smart Choices logo. The criterion for displaying the logo was derived from the National Dietary Guidelines for Americans. Any product which is low or has limited amount of total fat, saturated fat, trans fat, cholesterol, added sugars and sodium qualify to use the logo. The nutrition criteria covered food and beverages in 19 distinct product categories, including meats, fruits, vegetables, dairy and snacks (<http://www.smartchoicesprogram.com/>). However, since 23<sup>rd</sup> October, 2009, Smart Choices Program was voluntarily withdrawn and would be re-introduced after the FDA's new guidelines ([http://www.smartchoicesprogram.com/pr\\_091023\\_operations.html](http://www.smartchoicesprogram.com/pr_091023_operations.html) ).

### 2.6.1.8. Guiding Stars



**Figure 2.15: Guiding Stars Symbol (one star, two stars and three stars)**

The Guiding Stars Licensing Company was formed in early 2008. It was formed to generate opportunities for supermarkets, manufacturers, food service providers and other organizations to make grocery shopping simple for the consumers in US. The “Guiding Stars” symbol was patented by US (US Patent No. 7,974,881) in July 2011. It is a symbol that grades a product according to its nutritional value. The nutritional value of the products is determined according to the dietary recommendations set by FDA, USDA and WHO. The food products are eligible to carry the “Guiding Stars” symbol if they contain more vitamins, minerals, dietary fiber, whole grains and less fats, cholesterol, sugar and sodium. The more the nutritional value of the food is, the more the guiding stars it receives. If a food doesn't receive a star- it means it doesn't meet the criteria.

- One Guiding Star indicates good nutritional value
- Two Guiding Stars indicate better nutritional value
- Three Guiding Stars indicate the best nutritional value
- Over 100,000 foods are rated with “Guiding Stars” ([www.guidingstars.com](http://www.guidingstars.com)).

#### 2.6.1.9. Healthier Choice Pyramid



**Figure 2.16: Variants of Healthier Choice Pyramid**

The Healthier Choice Symbol (HCS) is found on packaged food products in Singapore. The food product carrying the symbol indicates that it is a healthier option as compared to the similar products within the same food category which does not carry the symbol. Therefore, the symbol enable consumers to arrive at a healthier option within no time while shopping for grocery. The symbol signifies that products carrying the HCS are lower in total fat, saturated fat, sodium and sugar. In few food categories, the product may also be higher in dietary fibre and calcium. For each different food category separate nutritional criteria are laid down. For example, breads that display the HCS symbol should contain no trans fat, less sodium (450 mg/100g) and more dietary fibre (3g per 100g) as compared to the regular bread. HSC guidelines cover approximately 60 food categories. Healthier Choice Symbol has some variants according to the purpose and those are:

**Healthier Snack Symbol (HSS):** HSS is a variant of HCS for snack foods. It includes product crisps and ice-creams. The eligible products for HSS are packed individually in small portions according to the serving sizes. Food products with HSS are generally lower in fat, saturated fat, sodium or sugar as compared to the regular products.

**Healthier Ingredient Symbol (HIS):** HIS is a variant of the HCS for healthier ingredients in a food product. It includes oil, table salt, oriental noodles, brown rice, bee hoon (soup-based seafood dish), soups and broth.

**Healthier Choice- Low Glycemic Index:** A new variant of HCS called low Glycemic Index (GI) was introduced in June 2013. It is particularly for low GI cereal products. The following criteria should be met by a product to have low GI symbol:

- At least 80% of the macronutrients within a food product must be contributed by carbohydrates or
- A special purpose food formulated for diabetics and
- Must have a GI value of less than 55. The cut-off values for the classification of low, medium and high GI are standardized internationally (ISO 26642:2010).

Further,

- The low Glycemic Index logo is only applicable to food products in the HCS cereal category (E.g. mixed rice, noodles, buns, cakes etc.)
- Must meet all the HCS nutrient guidelines as specified in the cereal category (<http://www.hpb.gov.sg/HOPPortal/health-article/2780>).

#### 2.6.1.10. Sensible Solution Program



**Figure 2.17: Sensible solution Symbol**

Kraft Foods Inc. (Glenview, Ill) started labeling some of its products with a green colored flag that contain nutrition information of the product. The flag is called Kraft's "Sensible Solution program" which makes it easy for consumers to locate healthier products that are "better-for-you," according to the company. This program uses nutritional criteria from 2005 USDA guidelines, FDA and National Academy of Sciences (NAS) to identify the products that meet specific nutritional criteria. Such products are Kraft's 2% Milk Shredded Reduced Fat cheese, Post Shredded Wheat cereal, Minute Rice Instant whole grain brown rice, Triscuit Original baked whole



grain wheat crackers and Crystal Light beverages. The products are labeled with Sensible Solution flag only when,

- The product has nutritionally-meaningful levels of beneficial nutrients like protein, calcium or fiber/whole grain.
- The product delivers a functional benefit like heart health or hydration.
- The product does not exceed set limits of calories, fat (including saturated and trans fat), sodium and sugar or if the product meets “reduced”, “low” or “free” caloric, fat, saturated fat, sugar or sodium specifications (Industry News and Innovations, 2005; <http://www.kraftfoodsgroup.com/SiteCollectionDocuments/pdf/nutrition-criteria.pdf> ).

Thus, various FOP nutrition labels vary in terms of their complexity and depth of information. The simple formats provide a judgement about the total product and the more detailed formats provide a judgement per nutrient. Therefore, the main aim of FOP labeling is to make nutrition labels easy to understand by most of the people regardless of their educational background.

## **2.7. Consumer Awareness and Use of Nutrition Labels**

Consumer awareness on food labels has an impact on usage, understanding and healthy food habits. Studies have shown an increase in interest among consumers for nutrition information which varies among products, people and situations (Grunert and Wills, 2007). Research conducted in USA showed that 90% of the women stated that they use nutrition information from the front of the package when shopping for food products (Bredbenner et. al, 2001).

A study among Australian consumers (females=26, males=10, aged 20-80 yrs) was carried out to explore the beliefs and attitudes towards fat related claims made on the packaged food labels. Results revealed that awareness about fat related claims especially “X% fat free” was high among consumers and the same influenced their purchase decision. The consumers were skeptical about all nutrient claims and they reported that they verify fat related claims on Nutrition Information Panel (NIP). Due to the inadequate time for shopping, consumers relied completely on the “fat related claims” ignoring other information on the food labels. Consumers also reported that in few products, claims like “fat free” was made and at the same time a small amount of fat was found on NIP which was misleading. Vegetable oils, fish oils and unsaturated fats were identified as good fats over saturated fats and animal fats by the



consumers. Some consumers believed that low fat claims encouraged them for consuming more of a product. Consumers want fat claims on the products which are usually high in fats namely, cheese, mayonnaise, milk and ice cream. Price, taste and natural ingredients were other factors influencing product selection by the consumers. Ninety two percent consumers wanted fat claim on cheese, 89% on milk and mayonnaise, 86% on ice creams, 81% on yoghurts and margarines, 72% on hamburgers and salad dressings and 25% and less on breads, canned fish, baked beans, jams, rice, canned fruits, fruit juices, canned tomatoes and frozen vegetables (Chan et. al, 2005). Demographic factors that influence the consumer's practice of reading nutrition labels while purchasing processed packaged foods have been discussed below:

- Gender
- Age
- Educational level
- Occupation
- Income group
- Family type (single/nuclear/joint family)
- Medical Condition
- Lifestyle
- Race

### **2.7.1. Demographic factors affecting consumer's practice of reading Food/Nutrition labels**

#### **2.7.1.1. Gender**

Gender affects the food label use and food choices (Nayga, 2000). Women were more interested in healthy eating than men (Grunert et. al, 2010; Grunert et. al, 2010b). More than males, females read food labels and information like ingredients, calories, product certification by standard agencies, etc. It was seen that housewives were the major food shoppers for grocery in the family and made food choices for the whole family. Now-a-days, they have started buying healthier food products that are high in fibre, low in calories and rich in beneficial nutrients (Vijayabaskar and Sundaram, 2012). Compared to women, men use less nutrition information than women because they do not agree that nutrition labels are useful. According to a study, women used almost two times more nutrition information than men while

shopping for grocery (Ranilovic and Baric, 2011). A study analysis on 1,382 subjects (males=573 and females=809) aged 19 to 70 years from National Health and Nutrition Examination Survey- 2005-2006 (NHANES) revealed that women used nutrition information namely, NFP, health claims, ingredient lists and serving sizes more frequently than men when making food choices (Stran and Knol, 2013).

#### **2.7.1.2. Age**

Study carried out in India demonstrated that most of the youngsters do not want to spend much time in looking for food labels (Vijayabaskar and Sundaram, 2012). In-store observation in retail outlets of UK revealed that although older respondents had less nutrition knowledge, still they were the ones who were more interested in healthy eating (Grunert et. al, 2010). Study in six European countries revealed that number of correct answers related to nutrition labeling decreased with age (Grunert et al, 2010b). In another study, older subjects (aged 51-70 years) used nutrition labels more frequently than their younger counterparts (Stran and Knol, 2013).

#### **2.7.1.3. Educational Level**

A study conducted in US revealed that snack food labels may not necessarily lead to informed food choices among patients. Ninety patients aged between 18-65 years were enrolled to assess the interpretational skills about package size and serving size on food labels. Results showed that all patients were able to identify the amount of calories per serving of the food however only 37% noticed that the food package contained multiple servings and considered the whole package as one serving. Lower educational level was directly related to low understanding and there was less understanding of “calories per serving size” and “total calories per package” (Pelletier et. al, 2004). Another study demonstrated that consumers with higher level of education were almost three times more likely to read nutrition labels at the point of purchase than shoppers with lower education. The reason for that could be that people with high education were better able to understand and use the nutrition information provided on the labels (Ranilovic and Baric, 2011).

A cross sectional survey among 200 primary care patients in US aged 18-80 years revealed that 89% patients reported of using food labels. An average of 69% of the questions was answered correctly by the patients. Some of the common reasons for incorrect answers cited in the study were incorrect application of the serving size, confusion due to other information on food labels and incorrect calculations. Poor

comprehension of food labels was significantly correlated with low-level literacy and computational/numeracy skills. However, patients with higher literacy also faced difficulties in interpreting food labels (Rothman et. al, 2006). Consumers with higher levels of nutrition knowledge were more likely to use the nutrition facts panel because they were more capable of understanding it (Barreiro-Hurle et. al, 2010a). Higher educational level (more than high school education) among women led to the practice of looking at nutrition labels more often than women with low educational level (Stran and Knol, 2013). Similarly, women with some college education were more likely to use food labels (Satia et. al, 2005). Consumers with higher knowledge on nutrition information provided by labels are more likely to use nutritional labels (Gracia et. al, 2007).

### **2.7.1.3. Occupation**

Two online surveys were conducted among consumers (n=237, aged 40 years and above) and dietitians (n=131, mean experience as dietitian=12.7 years) to assess and compare the factors affecting food choices and interpretational and computational skills of the two groups. Results revealed that consumers gave importance to saturated fat and trans fat while dietitians in addition to these two factors also gave importance to fiber content in the food. Health conditions of the consumers had a positive effect on looking for nutrients on the food labels. Consumers without any health condition were concerned about trans fat and saturated fat while those with CVD also looked for sodium in addition to saturated fat and trans fats. Consumers with diabetes were more concerned about sugar content in the food. On the other hand dietitians prescribed diets more precisely to their patients according to their health conditions. For e.g. for patients without any health condition dietitian prescribed diets keeping in mind the amount of trans fat and fiber, for CVD patients they suggested to look for saturated fat and trans fat while for diabetics fibre and carbohydrates were given more importance. Therefore, dietitians placed more focus on fiber, the general pattern for specific health conditions is generally similar for consumers as it was for dietitians. When food selection was looked into it was found that dietitians chose a menu lower in sodium, higher in total carbohydrates, higher in fiber and lower in protein. Therefore, findings suggested that dietitians were better able to minimize sodium and maximize fiber content in diet while consumers were more likely to minimize their carbohydrates and maximize their protein in diets. Study concluded that knowledge and skills required to interpret nutrition information does not depend upon the occupation or belonging to nutrition

background, rather it depends upon the consumer interest in choosing a healthy product (Basil et. al, 2009).

#### **2.7.1.6. Income Group**

Several studies have shown that there is direct relation of food label use and understanding with income group. Social grade has a direct relation with nutrition knowledge (Grunert et. al, 2010; Grunert et. al, 2010b). Income affects the use of claims. As consumer's income increases, so does the frequency of using claims when shopping for food products. Healthy habits were positively associated with nutrition knowledge and lower income was negatively associated with nutrition knowledge (Berreiro-Hurle et. al, 2010a). In contrast to above studies, National Health and Nutrition Examination Survey- 2005-2006 (NHANES) showed no relationship of income level with food label use (Stran and Knol, 2013). Data from India showed that higher-income groups consumed a diet with 32% of the energy from fat while the lower-income groups consumed only 17% of energy from fat. More recent dietary surveys in Delhi also confirmed that the upper income groups in urban India currently consume higher levels of energy from fat as compared with the urban poor or rural populations (Shetty, 2002).

#### **2.7.1.7. Family Type/Structure**

Family type affects the use of nutrition labels. Data from Spanish city showed that consumers living in larger households did not use nutritional labeling for making decisions for grocery. This may be attributed to the cost of time (more time) required in larger households and they do not want to spend too much time on shopping for grocery (Gracia et. al, 2007). It was revealed that households with children were more concerned about nutrition issues and search for nutrition information and thus has higher level of nutrition knowledge as compared to households without children (Berreiro-Hurle et al, 2010a).

#### **2.7.1.7. Medical Condition**

A study conducted among food shoppers (n=400) in Zaragoza, Spain to examine the consumer's knowledge about nutritional labels and their use. Results revealed that respondents who were female, educated, practiced some sport/exercise or were on prescribed diet had more knowledge about nutrition labeling (Gracia et. al, 2007). On the other hand, consumer's health habits and status influenced the use of both the

nutrition facts panel and claims (Barreiro-Hurle et. al, 2010a). Study done in Italy to explore consumer's (n=400) perceptions and use of nutrition labels showed that thirty eight percent of respondent's food selection aimed at maintaining good physique or product selection according to specific health problems, such as cardiovascular diseases (18%), diabetes (14%) and food intolerance (9%), while 6% of respondents were vegetarian (Annunziata and Vecchio, 2012). Another study highlighted that people with a nutrition-related chronic diseases used food label more frequently and thoroughly than those without any disease (Lewis et. al, 2009). People who were health conscious tend to assess the food label content more frequently and thoroughly as compared to their counterparts (Stran and Knol, 2013).

#### **2.7.1.8. Lifestyle**

Consumer's lifestyles also influence the nutrition label use. Hedonist consumers were less likely to use the nutrition facts panel but more likely to use the claims. On the other hand those who used nutrition facts panels also read the ingredients list more often. They also go for health check-ups regularly (Barreiro-Hurle et al, 2010a).

#### **2.7.1.9. Race/Ethnicity**

A study analysis on 1,382 subjects (males=573 and females=809) aged 19 to 70 years from National Health and Nutrition Examination Survey-2005-2006 (NHANES) revealed that "race" significantly affect the use of food labels. Hispanic men used NFP and other parts of the food label more frequently than white men (Stran and Knol, 2013).

### **2.7.2. Non- nutritional Factors Influencing Food Purchase**

The importance given to other non-nutrition related food attributes and time constraints minimise the use of nutrition labels (Barreiro-Hurle, 2010a). Major source of attraction for ready to eat products are packaging, aroma and taste, easy to cook, healthy, information on calories, rare ingredients, convenience in buying and quick turnaround time (Vijayabaskar and Sundaram, 2012). Price, taste, natural ingredients and size of the food packages were the other factors influencing product selection by the consumers (Chan et. al, 2005; Wansink, 2004). An investigation carried out in Italy revealed that 28% of the respondents considered nutritional properties as key attributes in influencing their purchasing decisions, although a higher importance was

given to other attributes of the product such as freshness (32.2%) and origin (28.4%) (Annunziata and Vecchio, 2012).

Across all six product categories (namely, breakfast cereals, yoghurts, ready meals, soft drinks, salty snacks and confectionery) studied in UK, the most common reasons cited by the consumers for choosing a particular product was taste (52%) followed by “this is what my family wants” (13.4%), price/special offer (10.7%) and health/nutrition (8%) (Grunert et. al, 2010b).

#### **2.7.2.4. Taste**

Several studies have found that taste was the most important factor that makes consumer selects a food product (Chan et. al, 2005; Grunert et. al, 2010b). Study conducted in UK showed that 31% of the consumers bought packaged foods placing the importance in taste (Grunert et. al, 2010).

#### **2.7.2.5. Price**

Price of the food product substantially influences purchasing decision of the consumers. (Finkelstein et. al, 2005; Lakdawalla et. al, 2005; Powell, 2009; Christian and Rashad, 2009; Drewnowski, 2007; Chou et. al, 2004; French and Stables, 2003; Epstein et. al, 2006; Ni-Mhurchu et. al, 2010; Block et. al, 2010; Chan et. al, 2008; Thomas et. al, 2011). An investigation among 47 mothers (aged 25-40 years) in New York, revealed that food purchases were reduced when prices of the food products were increased (Epstein et. al, 2007). Studies have also revealed that consumers who give more importance to “price” when purchasing grocery were less likely to use nutrition facts panel (Barreiro-Hurle et. al, 2010a; Chan et. al, 2005). In UK 14% of the consumers make food choices according to the price/special offer (Grunert et. al, 2010). Several other studies have shown that discount on the food products encourages consumers to buy the product (Chandon and Wansink, 2002; Mishra and Mishra, 2011).

#### **2.7.2.6. Convenience**

Ease of preparation is one of the most sought reason that influence food choices by the consumers. Consumers who highly appreciate ease of preparation are more likely to use the nutrition facts panel. Those consumers who are concerned about

convenience pay additional attention to nutrition information in order to combine ease of preparation with healthy eating (Barreiro-Hurle et. al, 2010a).

#### **2.7.2.7. Brand**

Consumers who paid more attention to the attractiveness and brand of the product seldom used nutrition information and claims. Consumers relied more on the overall image presented by the brand (Drichoutis et. al., 2005). An investigation in Italy revealed that 26.3% of the consumer's make food selection by brand of the product (Annunziata and Vecchio, 2012).

#### **2.7.3. Nutritional Factors Influencing Food Selection**

Nutritional factors namely, use of symbols and logos, nutrition and health claims, NFP, ingredients list, allergen information, information about colors, flavors, additives and preservatives and manufacture and expiry date are associated with the food selection. The studies supporting the same have been discussed below:

The use of the nutrition facts panel positively influences the use of the claim and vice versa. Most of the consumers used both nutrition facts panels and claims. However, a significant number of consumers used only one (33%) and of these, a majority read only the nutrition facts panel and paid no attention to claims (68%). One hundred and eighty-three consumers read only nutrition facts panels, while 85 read only claims (Barreiro-Hurle et. al, 2010a).

A multi-centric study was conducted in major retail outlets in six European countries (UK, Sweden, France, Germany, Poland and Hungary) to study the use and understanding of nutrition information on food labels on six product categories (namely, breakfast cereals, carbonated soft drinks, confectionery, ready meals, salty snacks and yoghurts). It was observed that 16.8% of shoppers looked for nutrition information on the label. Majority (38.5%) of the shoppers looked at Nutrition grid for nutrition information, followed by GDA labeling (29.2%), Ingredient's list (11.3%), Specific claim (5.7%), Health logo 95.1%), Traffic light (2.8%), Other (2.7%) and Color coded GDA (0.7%). The understanding of GDA labels was high in the UK, Sweden and Germany as compared to other three countries (Grunert et. al, 2010b).

#### 2.7.4. Prevalence of Label Use

An observational study from six European countries showed that respondents bought on an average 1.4 (1.2 in Hungary, Poland and Germany, 1.4 in Sweden and France, 1.8 in the UK) products in the aisle where they were observed and spent, on an average, 35 seconds per product purchase (28 in the UK and Germany, 30 in France, 31 in Sweden, 47 in Poland and Hungary). The average time was highest when buying ready meals (43 seconds) and lowest for salty snacks (31 seconds). It was demonstrated that food choices were not completely habitual and people took time to look at the products. It was also found that 62.6% of respondents were observed to have looked at the front of the package and 7.7% were observed to have looked elsewhere (Grunert et. al, 2010b).

A study conducted among UK consumers showed that 27% (of the total n=2019) of shoppers looked at nutrition information on the label, with guideline daily amount (GDA) labels and the nutrition grid/table as the main sources of information. Of those who looked for nutrition information, 86% of the consumers answered that they 'always' or 'regularly' looked for the same. The study also revealed that self-reported frequency of using nutrition information led to over reporting of about 50%. Consumer understanding of front-of-pack nutrition information was high (87.5%) and they were able to identify the healthier product.

A study conducted in Italy to explore consumer's (n=400) perceptions and use of nutrition labels highlighted that most of the respondents paid attention to food labeling occasionally (32%) or only when purchasing a new product (28%). Twenty six percent of respondents read nutrition labels regularly, while 14% did not read them at all. Most respondents (56%) cited that they read nutrition labels at the sales point during the purchasing of food. The motivation factors for doing so were "the need to get nutrition information" which was mentioned by 37% of the consumers while "the need for assessing quality features" before purchasing and consumption was reported by 34% of the consumers (Annunziata and Vecchio, 2012).

An investigation from six European countries showed that of those consumers who claimed to have looked for nutrition information on the package (n=1979, 16.8%), 74.7% had been observed to have looked at the product. Of those consumers who were observed of not having looked at the product in detail, but claimed to have looked at the nutrition information, 90.7% had bought the same product before as



they were already aware of the product qualities and recalled them from the previous purchases (Grunert et. al, 2010b).

#### **2.7.5. Effect of Nutrition Knowledge on Reading Food Labels**

Nutrition label usage is mainly related to the interest in healthy eating, whereas understanding of nutrition information is related to nutrition knowledge. A higher level of nutrition knowledge increases the number of correct answers related to nutrition labeling (Grunert et. al, 2010; Grunert et. al, 2010b). Nutrition information on food labels like Nutrition Facts Panel was given more importance by the consumers who valued nutritional characteristics of the product (Barreiro-Hurle et. al, 2010a).

#### **2.7.6. Reading and Understanding of Nutrition Facts Panel Information by Consumers**

An investigation carried out in UK revealed that of the 921 participants interviewed at home, more than two thirds answered correctly the questions on fat, calories, sodium, whole grains, salt, trans fat, sugar, fibre and omega-3 fatty acids. However, not more than 25% of the participants could answer the questions on polyunsaturated fat and monounsaturated fats. Participants indicated to avoid foods and drinks that were perceived to be high in fat, sugar or salt. Information that was most frequently looked on the food labels by the participants during in-store interviews (n=2019) were fat (49% of those who had looked for nutrition information) followed by sugar (35%), calories (33%), salt (20%), saturates (11%) and additives (10%) and the remaining nutrients were looked by less than 10% of the participants (Grunert et. al, 2010). Similarly, a study from six European countries showed that majority of the consumers looked for calories (39.6%), followed by fat (38%), sugar (33.8%), other nutrients (25.4%), food additives/colors/preservatives/E-numbers (13%), carbohydrates (12.3%), sodium/salt (9%), vitamins (7.2%), protein (5.8%), saturated fat (5.6%), fiber (5.6%) (Grunert, 2010b).

#### **2.7.7. Sources of Nutrition Information about the Product**

Study conducted in Italy to explore consumer's (n=400) perceptions and use of nutrition labels revealed that 31% of the respondents mentioned personal physician or nutrition expert advices as the most important source to get nutritional information about the food products they buy, followed by newspapers/magazines (22%),

television (19%), nutrition/food labeling (18%) and family members or friends (10%) (Annunziata and Vecchio, 2012).

#### **2.7.8. Kind of Products for which Nutrition Labels are more Frequently Read**

Study conducted in six European countries revealed that 27% of the UK consumers looked for nutrition information followed by consumers from Germany (19.7%), Hungary (18.8%), Poland (13.8%), Sweden (13.5%) and France (8.8%). Across countries and product categories, 16.8% of the shoppers said that they looked for nutrition information. Shoppers looked for nutrition information when they bought yoghurt (23.5%) and breakfast cereals (24.5%) (Grunert et. al, 2010b). A study showed that the level of attention devoted to the labels varied according to the type of products purchased. Consumers read nutritional labels more frequently when they buy children foods (34.2%), cookies and snacks (31.6%), fruit juices or soft drinks (22.4%) and cereals (26%) (Annunziata and Vecchio, 2012).

#### **2.7.9. Interpretation of Nutrition Labels by Consumers**

Focus group discussions conducted in New Zealand among six groups (namely, Maori, Samoan and Tongan and three low income groups) showed that all groups had seen Pick the Tick logo before. All the groups knew about the logo except Samoan from advertisements, supermarkets, family doctors, dietitians and from their children. Participants identified the logo as the identification mark for a healthy product, healthy food for heart or as recognition of the contract between the food manufacturer and the New Zealand National Heart Foundation (NHF). The participants believed that the logo usually appears on costly products and they cannot afford to buy them. Some of the participants believed that logo is easier to understand as it is pictorial and had minimal writing however it is too small in size to be read. Ninety percent of the participants from LIG group never considered the logo for product selection as it only appeared on costly food items, they did not know about its significance and they do not have time to look for it. One participant from Maori group was unsure whether Pick the Tick logo was intended for young people or just for people with heart problems. Forty six percent of the participants from Tongan group used the logo occasionally, 23% often and 30.8% never. None of the participants from Samoan group reported using the logo to guide their food choices (Signal et. al, 2007).

### 2.7.10. Consumer Studies on Use and Understanding of Different Front-of-Pack Models in Various Countries

Study conducted among 921 UK consumers on conceptual understanding of FOP nutrition label formats revealed that 61% of the respondents correctly identified GDA labeling. Forty seven percent of the respondents correctly answered that GDAs present nutrients as “per serving” of the food product. Eighty nine percent of the respondents had the understanding that GDA for fat of 70 g means that an average adult should not eat more than 70 g fat a day. Responses on Traffic Light labeling showed that 23% of the respondents knew that Traffic Light can be given as “per 100 g” and “per serving.” However, consumers had difficulty in distinguishing the meaning of the colors in Traffic Light labeling (Grunert et. al, 2010).

An internet based randomized study on consumers (n=703 adults) was conducted to compare the understanding of newly launched FOP labeling system Facts Up Front (FUP) by the food manufacturers in US and Multiple Traffic Light system (Traffic Light). Results revealed that participants who were given Traffic light labels performed better than those given Facts-Up-Front (Roberto et. al, 2012).

A cross sectional, descriptive study conducted in Sweden among 4,259 obese middle aged subjects versus 1,092 healthy subjects as reference group to investigate snacking frequency in relation to energy and food. It was found that obese group consumed snacks more frequently compared to the reference group and women more frequently than men. Energy intake increased with increased snacking frequency, irrespective of the physical activity. Statistically significant difference was observed between energy intake and snacking frequency for cakes/cookies, candies/chocolate and desserts. Energy intake increased more by snacking frequency in obese subjects than in reference subjects. Obese subjects were more frequent snackers than reference subjects and women were more frequent snackers than men. Snacks were positively related to energy intake, irrespective of physical activity. Sweet, fatty food groups were associated with snacking and contributed considerably to energy intake. Therefore, the study recommended that snacking should be considered in obesity treatment, prevention and general dietary recommendations. Number of intake occasions was independently related to obesity, increased snacking frequency was associated with higher energy intake in all four groups (obese men, obese women, reference men and reference women), however, the trends were steeper in the obese group. The metabolic variables blood pressure,

b-glucose, s-insulin, s-cholesterol, s-triglycerides and s-HDL were not significantly related to snacking frequency in any of the four study groups. Therefore, Swedish obese men and women were more frequent snackers than Swedish reference men and women and also that women consumed more snacks than men (Forslund et. al, 2005).

#### **2.7.11. Barriers in Reading and Understanding Nutrition Labels**

Study carried out in Italy to explore consumer's (n=400) perceptions and use of nutrition labels revealed that around 62% of the respondents believed that the information given on the nutritional label was difficult, 72% of respondents viewed nutritional information as too technical and difficult to understand while 86% of the respondents complained that the letters of the nutritional table were too small and barely visible. Around 73% of respondents did not understand the actual nutritional values related to a single serving Fifty two percent respondents thought that nutrition claims are not very reliable. (Annunziata and Vecchio, 2012).

Focus group discussions carried out in Wellington region of New Zealand among six groups (namely, Maori, Samoan and Tongan and three low income groups) demonstrated that the participants rarely used nutrition labels for the reasons namely, lack of time, lack of understanding, shopping habits and relative absence of simple nutrition labels on the low-cost foods (Signal et. al, 2007). The participants wanted nutrition labels to be bright colored, simple, more use of pictures than words and bigger. Groups preferred either multilingual or local language labels. Technical language like "saturates" were difficult to understand by the participants. All groups preferred Traffic Light System (TLS) except Samoan group as they were not exposed to nutrition labels and faced difficulty in identifying a preferred label from the given options. There was little support for pyramid logo as it was difficult to understand. Out of six groups, three groups, Maomi, Tongan and Samoan wanted supermarkets should label aisle as healthy products and unhealthy product sections. Majority of the participants had seen Nutrition Information Panel (NIP) but reported it as difficult to understand due to its terminology and numeric nature. Only 3% of the participants from low-income group reported of using the NIP 'often' to help decide what to buy, 17% used them 'occasionally' and 80% 'never' used them. Participants from Maori group identified nutrition information namely, Pick the Tick logo, NIP and serving size (Signal et. al, 2007).

A further small study based on focus group discussions with eight low-income food shoppers found a general lack of understanding of nutrition label components (Sullivan, 2003). This lack of understanding was compounded by other perceived barriers in buying healthy foods such as restricted food budgets. Although these studies suggest that low-income shoppers may have lower use and understanding of nutrition labels, another study among 919 low-income shoppers found that reported use of nutrition labels was significantly associated with improved dietary quality suggesting that there is an association between label use and dietary quality although the direction of this effect cannot be determined (Bhargava, 2004). Consumers found difficulty in distinguishing between nutrient claims and health claims (Derby and Levy, 2001). Thus, parallel to creating awareness among consumers, food labels need to be simplified for improved consumer understanding.