*Review Article***Diet and Nutrition in the Prevention of Non-Communicable Diseases**

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(Received on 30 April 2016; Accepted on 03 May 2016)

Worldwide non-communicable diseases (NCDs) occur due to multiple etiological factors impacting development and economic progress. Developing countries have dual burden of diseases viz., under and over nutrition, which are critical public health challenges. NCDs occur a decade earlier in India. Changing economic scenario, evolving agriculture practices, rapid strides in industrialization, migration, urbanization, globalization and trade liberalization impact the food environment. The resulting dietary transitions lead to replacement of whole/coarse grains/grams with refined foods. Availability, affordability and accessibility of energy- dense foods with excess unhealthy fat, sugar, salt and animal foods, have replaced traditional foods. The intake of healthy horticulture produce such as vegetables, fruits, legumes/pulses, nuts, seeds and fish are inadequate. Broad diversified dietary patterns rather than single foods/nutrients have healthy outcomes. Excess alcohol and tobacco add to the insults. Physical activity has reduced in all segments of the population and domains of physical activity. These steering dynamics change the lifestyles leading to obesity and shifting disease patterns which have overwhelming effects on human capital and the health system. Proactive prevention with comprehensive policies cutting across several risk factors with consensus from all stake holders including the private segment is essential to tide over the crisis. The WHO has committed to reduce under-nutrition, obesity and diet-related NCDs, monitor policy response and catalyse effective actions to achieve specified targets by 2025. The national governments must create the enabling environment to achieve the same. India has initiated action-oriented program for risk reduction with the Health Ministry as the nodal agent for NCD prevention and control.

Keywords: Non Communicable Diseases; Dietary/Nutrition Transition; Physical Activity; Diabetes; Cardiovascular Diseases; Cancer

Introduction

Worldwide, Non Communicable Diseases (NCDs) are of great public health significance and associated with very high mortality and morbidity impacting human capital and economy. Though, the pharmaceutical industries have several curative and palliative measures to quench the rising epidemic, the health outcomes are not very significant. It is obvious therefore that these diseases of public health concerns need better preventive strategies supported by policies and programs. These diseases affect populations in developing countries a decade earlier. According to the Director General of WHO, “*The world has*

reached a decisive point in the history of NCDs and has an unprecedented opportunity to alter its course” (WHO, 2013). Demographic, socio-economic aspects, technological innovations, migration, rapid urbanization, globalization, dietary/nutrition transition, motorized transport, physical inactivity, stress and personal habits/alcohol consumption and use of tobacco are the major drivers of epidemiological transition leading to obesity (higher body fat) and NCDs.

Developing countries such as India primarily concentrate on under-nutrition and rightly so, but can no longer neglect diseases due to over-nutrition.

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Developmental origins of adult diseases due to foetal malnutrition and programming are well documented as risk factor for NCDs in adults (Barker, 1998) and have trans-generational effects. A higher intake of energy- dense foods, refined and fatty foods, processed/convenience and animal foods, salty and sugary snacks, low intake of whole grains, vegetables, fruits and nuts coupled with physical inactivity result in NCDs. Hence, prevention strategies as public health measures must have applicable and realistic goals for these challenging issues. We need to seize this opportunity to act on time. This article encapsulates the current determinants of NCDs and presents dietary strategies for prevention of diabetes, cardiovascular diseases (CVD) and cancer. Both global and Indian scenario is portrayed.

Burden of Non-communicable Diseases (NCDs)

In 2012, mortality worldwide due to NCDs was higher than due to communicable diseases-maternal, neonatal, and nutritional disorders (Fig. 1A). CVD, diabetes, cancer and respiratory diseases were the most common causes of death. Almost 16 million deaths due to NCDs were premature and 82% of these premature deaths occurred in the developing world (low-middle income countries-LMIC).

In parallel with global mortality rates, NCDs accounted almost for two third (60%) deaths in India in 2012(Fig.1A). Deaths due to NCDs both in the world and India are given in Fig. 1B (WHO, 2014 & WHO 2014a). About 12 % of heart attacks in India occur a decade earlier (<40 years of age) than the world's average age of 50 years (WHO 2014). India has dual burden of diseases at both ends of nutrition spectrum, one telescoping into other, compelling strategies to address both groups of disorders (Marshall, 2004).

The deaths are due to superimposed poor health behaviours mainly tobacco usage, unhealthy diet, physical inactivity and alcohol consumption. Smoking is estimated to cause about 71% of all lung cancer deaths, and nearly 10% of CVD (WHO, 2010). About 1% of disability adjusted life years (DALYs) and 2.8% of mortality globally are due to low fruit and vegetable consumption (WHO, 2003) while 5.7% of deaths and 2.1% of global DALYs are attributable to physical inactivity. In India 15% of deaths are due to tobacco, 4.3% due to alcohol, 1.9% due to overweight/obesity

and 21.1% due to high blood pressure (WHO, 2014). It therefore warrants the attention of policy makers, public health scientists, clinicians as well as civic societies.

Economic Burden of NCDs

NCDs are reported as the major global threat to economic development particularly in LMIC due to increased morbidity, mortality, decreased quality of life and life expectancy. An average economic loss of nearly US \$500 billion per year (2011-2025) is estimated from the 4 diseases (diabetes, CVD, cancer and chronic obstructive pulmonary disease (COPD)) in LMICs (WHO, 2010).

Bloom *et al.* (2011) have calculated the economic burden of NCDs in India *viz.* type 2 diabetes, CVD, COPD, cancer and mental health between 2012-2030 to be US \$4.58 trillion loss due to reduced savings, reallocation for treatment, and inevitable loss of productivity of sick or dead workers. Thakur *et al.* (2011) reported the cost of NCDs is about 5-10% of GDP in India .NCDs enhance the household medical expenditure (Patel *et al.*, 2011).

Reduction of economic growth by 0.5% was observed for every 10% increase in mortality due to NCDs (Abegunde and Stanciole, 2006).

Non-Dietary Determinants of NCDs

Among the major non-dietary determinants of NCD are: demographic transition, globalisation, trade liberalisation, industrialisation, socio economic factors, migration & urbanisation. Rapid demographic transition is occurring in developing world without the social changes such as improved living conditions, better nutrition, income growth and better access to public health services that occurred in most developed countries decades ago (Engelgau, 2011). In India thanks to improved health care, the crude birth, death and infant mortality rates have registered a significant decline from 1971 to 2013 (Census 2013) with consequent increase in economically active (63.3%) and elderly population (8.3%). Yet NCD-related DALYs are alarmingly high in the early ages and it would be best to invest in this prime age group and proactively prevent NCDs.

Globalization refers to an increased flow of finances, traded goods and migration of people and

Fig. 1: (A) Causes of mortality, (B) Mortality due to non-communicable diseases

new concepts resulting in economic, political and social interdependence (Shetty, 2003). The global value of food trade has gone up enormously (18%) with export of foods becoming twice (6%) that of non food items (3%) (International Trade Statistics, 2015).

When agriculture was introduced into global trade, all aspects of food production and processing transformed agro-food industries into large multinational corporations with powerful marketing strategies. The economic liberalisation policies and foreign direct investment enhanced food processing (FAO, 2004; WHO, 2007). The economic growth in Asian countries resulted in higher consumption of unhealthy foods due to aggressive sales at affordable costs. These are the global catalysts of the growing epidemic of NCDs (Stuckler *et al.*, 2012). The GDP growth rate in India is 7.5% in 2015-2016. A total of 43% in urban and 53% in rural monthly consumption expenditure was on food and beverages in the year 2013-14 in India as against 9% in USA (Credit Suisse, 2015).

Even though economic growth is impressive in developing countries, disparities between and within

countries exists. Low birth weight due to *in utero* under-nutrition in low-income population increases the vulnerability to NCDs mainly obesity, type 2 diabetes and CVD (Yajnik, 2004). In India, prevalence of hypertension was found to be statistically similar in selected communities of all socio-economic status (SES) groups (Xaviers *et al.*, 2008). A multi centric study of 50 cities in India reported that death rate due to CVD was significantly high in low SES group (8.2%) compared to high SES group (5.5%) (Subramanian *et al.*, 2013). These signify that India needs to revise the health care policies for universal access with equitable distribution.

Almost 32% of the Indian populations are urbanites (World Bank report, 2014). The speed of urban growth has led to innumerable lifestyles and social changes that have a remarkable effect on disease patterns. According to NSSO (2010), 35% of India's urban population constitutes rural migrants, mostly in search of employment and education. This has indirectly impacted home cooked foods. Many prefer cheap and quick meal options of street foods, which are unhygienic, unhealthy- high in salt, fat and sugar (WHO 2010).

Behavioural Risks

Among the major behavioural risk factors are: Physical inactivity in adults as well as children, alcohol consumption, smoking and use of tobacco; and diet and nutrition transition. Physical inactivity has been identified as the fourth leading risk factor for global mortality (6%-WHO, 2010). Studies conducted in 122 countries covering almost 89% of population, indicated 31% of adults are inactive (Hallal *et al.*, 2012). Promotion of Physical activity (PA) appears to be similar to prevention of smoking or obesity on NCD mortality rates (Swaminathan *et al.*, 2013) as PA has several metabolic health benefits (Fig. 2- Warburton *et al.*, 2006) However, the present discussion will be confined to diet and nutrition transition due to constraint of space.

Diet and Nutrition Transition

Globally diet/nutrition transition has accelerated all chronic diseases and currently developing countries are going through the same phenomenon (Shetty, 2003; Popkin *et al.*, 2012). The green revolution in India (1970) changed the nutrition scenario from

Fig. 2: Metabolic health benefits of physical activity

hunger and famine to food surplus and export. However, income inequality in India is still persisting with consumption among the poorest being qualitatively and quantitatively poor while the wealthiest produce and consume more. Due to changes in food availability and accessibility, consumption of relatively unhealthy processed and packaged foods, rich in refined grains, oils, salt and sugar has increased. Consumption of whole grains, nuts, fruits and vegetables has not registered significant increase (Radhika *et al.*, 2009, 2011; Ramachandran, 2011; Misra *et al.*, 2011; Kapil and Sachdev, 2012).

A recent analysis of changing food consumption pattern in India (National Council of applied economic research, 2014), data from National Sample Survey organization (NSSO, 2014) and NNMB (2012) show that over the years cereal consumption has declined markedly with attrition of millets. Consumption of protective foods such as pulses, milk, vegetables (except starchy potato) and fruits which are sources of proteins (pulses), fiber and micro/phytonutrients (vegetables) continues to be low. All of them impact glycaemic index (GI) (Fig. 3). Though consumption of animal foods are low milk, fish and poultry have shown improvements but that of mutton declined. However none of these databases capture foods consumed outside the home environment, which can add to refined foods, sugar, salt and fat intake.

While the consumption of energy, carbohydrates and proteins has declined, that of fat has gone up marginally (Fig. 4). The diets in general continue to be qualitatively markedly deficient in micronutrients, particularly vitamins A, B2 (riboflavin), folic acid iron

and calcium. Estimates of Vit.B6 and zinc intake are not available. Deficiencies of vitamins such as Folic acid, B12 and B6 can result in elevated homocysteine, a vascular damaging amino acid. Vitamin D deficiency is now recognised as a public health problem which may impact negatively glycaemic control.

Refined Grains

The visible change in dietary ingestion of the populations across the globe is a shift towards refined carbohydrates (polished rice and refined wheat flour) and processed refined cereals replacing coarse grains (Hu, 2011; Anand *et al.*, 2015; Reddy, 2002). Refining retains starchy endosperm with loss of bran, germ and key nutrients (Shobana *et al.*, 2011). The loss of bran and pulverization of the endosperm aids in rapid digestion and absorption of carbohydrates from refined grains than whole-grain products increasing blood glucose and insulin concentrations (Hu, 2003). Thus the staples consumed in today's world are refined, containing only the starchy endosperm with glycaemic carbohydrates strongly associated with obesity and chronic diseases.

Sugar and Sugar-sweetened Beverages (SSB)

Over the last 50 year the consumption of sugar across the world has almost tripled (Lustig *et al.*, 2012). SSB and other energetic beverages have increased to about 17-25% of total energy intake in all age groups (Popkin *et al.*, 2010). SSB industry is third largest industry in India after biscuits and tea. SSBs and total sugar intake is high (traditional + SSB) among Indians (25kg/capita/annum) compared to worldwide consumption (23.7kg/capita/annum) (Gulati and Misra, 2014). The sales of SSB have increased in India by more than 10% annually since 1998 and have exceeded 11 litres/capita/year (Foodnavigator-USA.com, 2011). This may be due to aggressive marketing and sales of SSB despite the efforts made by medical experts and health organizations to limit the consumption of sugar (Taylor *et al.*, 2011; Basu *et al.*, 2013).

Edible Oils and Fats

Visible fats and oils provide almost half of fat calories in an average Indian diet (Ghafoorunissa, 2007). Data from FAO suggest a rise in the percentage of dietary energy supply from fats (14-19%) and vegetable oils

Source: NSSO 68th round, 2014

Figs. 3: Trends in foods and nutrient consumption

(6-10%) in India from 1980 to 2000 (FAO, 2004; WHO/FAO, 2003).

In addition to cooking oil, *ghee* (clarified butter), *vanaspati* (hydrogenated oils) and butter are the source of dietary fat among South Asians. In India *ghee* and *vanaspati* (latter rich in trans fatty acids-TFA) are also used as bakery shortening and in the preparation of commercially fried, processed, baked, ready-to eat foods, and street foods (Anand *et al.*, 2015). Joint WHO/FAO report 2003 recommends the TFAs intake to be limited to <1% of total daily energy. A study among adolescent and young adults in north India reported the TFAs intake (%E) to be 1.11 and 1.13 respectively (Misra *et al.*, 2009). *Vanaspati* and bakery shortenings can contain as high as 50% trans

fat (L'Abbe *et al.*, 2009). Food Safety Standards Authority of India (FSSAI, 2010) recommended TFA content in *Vanaspati*, to be reduced to 5% by 2013 and made it mandatory to specify the amount of TFAs on the label of all food products.

Animal Foods

The increase in the production and consumption of animal foods including milk and meat are primarily contributed by developing countries of the World (Kearney, 2010). By 2020, developing countries will produce 63 % of meat and 50 % of milk and will consume about 107 million metric tonnes (MMT) meat and 177 MMT milk. In India almost 60% are non-vegetarians (The Hindu, 2006).

Source: NSSO 68th round, 2014

Figs. 4: Trends in foods and nutrient consumption

Consumption of animal-foods has both beneficial and undesirable health effects. Animal foods help to significantly improve the protein and micronutrient profile in developing world. However excessive meat intake is associated with high saturated fat intake and thereby increases total mortality due to NCDs (Sinha *et al.*, 2009).

Processed Foods

Most foods are processed to improve the shelf life, taste and reduce wastage and contain huge amounts of sugar, salt and preservatives. In India, though the food processing is in its infancy, it is ranked fifth in terms of production, export and expected growth (Ministry of Food Processing Industries, 2007). Only 25% is in the organized sector, while 42% is in unorganized sectors and the rest is from small

establishments. It adds to the economy with compound annual growth rate (CAGR) of 8.4% (Rais *et al.*, 2013).

The marketing of food has clearly influenced dietary shifts. Studies have shown that transnational supermarkets have reduced demand for homemade foods or foods from local markets by expanding available choices of packaged and processed foods to the consumers (Hawkes, 2006). Food sector advertisements targeted at children in Asia, ranges from 25% in South Korea, to 40-50% in India, 50-75% in Pakistan and Philippines, and 70% in Malaysia (Escalante De Cruz *et al.*, 2004).

Diet and Diabetes

Diabetes as on 2015 affected >415 million adults

worldwide and is expected to affect 642 million by 2040. India is one of the epicentres of diabetes with 69.2 million adults in 2015, which is projected to increase to 123.5 million in 2040 (IDF, 2015). Anjana *et al.*, 2011 reported that the prevalence of pre-diabetes and diabetes in India is 77.2 million and 62.4 million respectively. Diabetes is more often encountered in affluent society but very soon it would affect the poorer segments as well and therefore we need to promote simple strategies such as PA and healthier dietary options (Unnikrishnan *et al.*, 2016).

There is a strong association of excessive weight gain particularly central adiposity and risk of developing type 2 diabetes (ADA, 2015). Indians in general have high body fat (visceral fat) for the same BMI. Weight loss diets including exercise (2 to 3 years) improves insulin sensitivity and reduces risk progression from impaired glucose tolerance to type 2 diabetes (Hinderliter *et al.*, 2011). A multi centred long term trial had shown that weight loss of 4-8 kg in a year in adults with type 2 diabetes resulted in significant improved lipid profile, urinary creatinine and blood pressure (Espeland, 2007). The Indian Diabetes Prevention Programme (IDPP) had shown that physical activity and diet modification (life style modification-LSM) could prevent diabetes in Asian Indians (Ramachandran *et al.*, 2006).

Dietary carbohydrates (dietary glycaemic load-GL) are positively associated with the risk of type 2 diabetes in Indian population. Dietary fibre showed strong inverse association with the risk of type 2 diabetes (Mohan *et al.*, 2009). The high GI and GL diet along with low fibre content increases insulin demand and further leads to pancreatic β cell exhaustion, higher lipids with low HDL and waist circumference (Radhika *et al.*, 2009) and CVD (Willett *et al.*, 2002). A recent meta-analysis of cohort studies showed an inverse association between whole grain intake and the risk of type 2 diabetes (Aune *et al.*, 2013). Substituting brown rice over white rice significantly lowered blood glucose and insulin levels (Sun *et al.*, 2010; Mohan *et al.*, 2014). Higher intake of SSB (1-2 servings a day) showed 26% greater risk of developing type 2 diabetes independent of obesity leading to inflammation, insulin resistance, and impaired β -cell function (Malik *et al.*, 2010).

The quality of fat consumed is more important than the total fat intake to support metabolic goals in

type 2 diabetes (ADA, 2015). Poor insulin sensitivity is observed with high concentration of SFA in serum lipids and muscle phospholipids (Foloso *et al.*, 1996). In humans, replacement of unsaturated over saturated fats improves insulin sensitivity and metabolic abnormalities (Riccardi *et al.*, 2004). However, a very high intake of omega-6 PUFA (9-21%E) with low omega-3 (0.7%E) in the diet was positively associated with insulin resistance and metabolic syndrome among Indians (Lakshmipriya *et al.*, 2013). Diets rich in Mono unsaturated fatty acids (MUFA) and omega-3 fatty acids such as Mediterranean dietary pattern as against pharmaceutical preparations of omega3 (Wheeler *et al.*, 2012) have shown beneficial effects on glucose and lipid levels in type 2 diabetes (ADA, 2015).

Proteins (legumes) improve insulin response without altering blood glucose levels and is strongly recommended for reducing the risk of type 2 diabetes (Jenkins *et al.*, 2012). Brown rice with legumes showed 23% lower glycaemic response compared to white rice diet among overweight Asian Indians (Mohan *et al.*, 2014). Functional foods/ingredients help in reducing blood glucose, lipid levels and inflammation. The details of functional foods are being covered in a separate chapter.

It is common in epidemiology to quantitate risk as convincing, probable, possible and insufficient based on specific criteria and usually prospective cohort studies using disease end points are considered best. The strength of evidences of various dietary factors on risk of type 2 diabetes is shown in Table 1.

Diet and CVD

CVDs are the leading cause of death worldwide and accounts for 1/4th of all deaths in India (Chauhan and Aeri, 2013). Between the year 2003 and 2008 the prevalence of CVDs increased in rural areas (3-6%) and in the urban areas (8-12%). Just as for diabetes CVD is high in young adults (Shokeen and Aeri, 2015).

The strength of evidences of various individual nutrients on risk of CVD is shown in Table 2. Though fats have been the focus of attention for CVD, recent analysis of the Minnesota coronary experiment replacing saturated fats with omega 6 indicated that despite the reduction in serum cholesterol it did not reduce mortality from coronary heart disease

Table 1: Dietary Factors - Strength of Evidences on Type 2 Diabetes Risk

Convincing	Probable	Possible	Insufficient
RISK of TYPE 2 DIABETES			
<ul style="list-style-type: none"> Overweight and obese individuals in particular with central obesity 	<ul style="list-style-type: none"> Intake of carbohydrates containing foods with added fat, sugars and sodium Sugar-sweetened beverages High sodium intake (> 2,300 mg/day) may increase the risk of hypertension in adults with type 2 diabetes 	<ul style="list-style-type: none"> Saturated fats Trans fatty acids Excess Alcohol consumption 	-
RISK of TYPE 2 DIABETES / Improves Glycaemic Control			
<ul style="list-style-type: none"> Dietary goals to be individualized as an effective measure 	<ul style="list-style-type: none"> Carbohydrate intake from vegetables, fruits, whole grains, legumes and dairy products 	<ul style="list-style-type: none"> Substituting low glycaemic load foods with high glycaemic load foods 	<ul style="list-style-type: none"> Use of cinnamon, fenugreek, oats or other herbs/supplements for the treatment of diabetes
<ul style="list-style-type: none"> Promote modest weight loss using life style intervention for overweight/obese adults 	<ul style="list-style-type: none"> Dietary fibre intake (14 g fibre/1000 kcal/day) Half of the grains consumed should be whole grains 		<ul style="list-style-type: none"> Routine use of micro-nutrients such as chromium, magnesium, and vitamin D, E, carotene and antioxidants to improve glycaemic control in diabetes
<ul style="list-style-type: none"> Carbohydrates (quality/quantity) affect available insulin and post prandial glycaemic response 	<ul style="list-style-type: none"> Protein increase insulin response The consumption of fish (particularly fatty fish) at least 2 servings (c.a. 85g/serving)/ 2 times per week Mediterranean diet (a diet rich in MUFA) 		
TYPE 2 DIABETES (no relation)			
<ul style="list-style-type: none"> Omega-3 supplements for people with diabetes for the prevention or treatment of CVD events 	-	<ul style="list-style-type: none"> Benefits from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies 	-

Adapted from ADA 2015

(Veerman, 2016). Cholesterol controversy apparently continues as the recent American dietary guidelines removed limits for dietary cholesterol (USDHHS, 2015-2020).

Compared to individual foods, dietary patterns have more influence on CVD. An INTERHEART study in 52 countries showed unhealthy dietary pattern (western diet) increases the risk of acute myocardial infarction (MI-35%) globally (Iqbal *et al.*, 2008). Fruits and vegetables consumption accounted for 30% of risk reduction of MI (Yusuf *et al.*, 2004). Rastogi *et al.* (2004) showed that consumption of green leafy vegetables associated with a lower risk for ischemic heart disease among Indians. A cross-sectional study

among Chennai urban adults showed that high intake of fruit and vegetable resulted in a 48% protective effect against CVD (Radhika *et al.*, 2008). Investigations suggest that a diversified dietary pattern with healthy nutrients has an aggregated effect on CVD (AHA, 2006).

The three types of diets mainly Dietary Approaches to stop Hypertension (DASH) diet; Mediterranean diet and vegetarian diets have shown better results on decreasing blood lipid and CVD risks. The DASH dietary pattern is high in vegetables, fruits, low-fat dairy products, whole grains, poultry, fish, and nuts and low in sweets, SSBs, red meats, saturated fat, total fat, and cholesterol. It is rich in potassium,

Table 2: Dietary factors - strength of evidences on CVD risks

<div> CVD Risk </div>		<div> CVD Risk </div>	
		Convincing Evidence	
§	SFA: Myristic and palmitic acid	§	Regular physical activity
§	Trans fatty acids	§	Fish and fish oils (EPA &DHA)
§	Sodium Intake	§	High vegetables and fruits intake
§	High alcohol consumption	§	Potassium
§	Replacing SFA with TFA	§	Low to moderate alcohol intake
		§	Replacing SFA with carbohydrates
		§	Replacing carbohydrates with MUFA
		Probable Evidence	
§	Dietary cholesterol*	§	α Linolenic acid
§	Unfiltered boiled coffee	§	Oleic acid
		§	Non starch polysaccharides
		§	Whole grain cereals
		§	Nuts (unsalted)
		§	Plant sterols/stanols
		§	Folate
		Possible Evidence	
§	Fats rich in lauric acid	§	Flavonoids
§	Beta carotene supplements	§	Soy products

*Current American dietary guidelines do not emphasize dietary cholesterol as a risk factor.

Adapted from WHO/FAO report 2003 and FAO 2010

magnesium, and calcium, as well as proteins and fibre. Intervention trials of DASH diets have shown promising evidences on low density lipoprotein-LDL and total cholesterol-TC/High density lipoprotein (HDL) ratio and no effect on triglycerides-TG (NHLBI, 2013; Eckel *et al.*, 2014).

Mediterranean diet emphasizes high intake of fresh vegetables, fruits, whole grains, legumes, nuts, and olive oil, moderate to high intake of fish and moderate intake of low fat dairy products, eggs, chicken and small to moderate quantities of wine with meals while red meats are avoided (Shai *et al.*, 2008). The Mediterranean diet tends to be relatively high in dietary fat (40%-50% fat calories), predominantly as MUFA 15-25% while SFA is limited to $\leq 8\%$ Energy. The Lyon Diet Heart study found that among adults following Mediterranean diet, recurrent CVD was reduced by 70% (Michel De Lorgeril *et al.*, 1999). An intervention of Mediterranean diet with extra-virgin olive oil, or mixed nuts and a control diet (among participants at high CVD risk) demonstrated extra-virgin olive oil had 30% or nuts 28% reduction in the incidence of major cardiovascular events compared

to control diet (Estruch *et al.*, 2006).

The Indian Migration Study (IMS) carried out in 4 cities of India to assess the impact of vegetarian diet (with no animal foods and eggs) showed lower levels of TC, TG, blood pressure and fasting glucose levels compared to non-vegetarians (Shridhar *et al.*, 2014).

Hypertension

Raised blood pressure (BP), accounts for 54% of strokes and 47% of coronary heart disease (Lawes *et al.*, 2008). Excess dietary salt intake accounts for 17-30% risk for hypertension (WHO, 2012). High dietary salt intake has also been associated with stroke, direct vascular damage, obesity, stomach cancer, osteoporosis, kidney stones and also increased thirst (WHO, 2014). According to a nationwide India Diabetes study, 1/5th of the Indian population is hypertensive and consumes dietary salt higher than the recommended -6g/person/day (Bhansali *et al.*, 2014). Radhika *et al.* (2007) observed that salt intake significantly correlates with the prevalence of hypertension in Chennai urban population. NNMB

report (2012) indicates that 20% of hypertensives in rural area consume more than 5g/person/day. Adults with type 2 diabetes or at least 3 CVD risk factors on Mediterranean diets showed a reduction of BP by 6-7/2-3 mm Hg (Eckel *et al.*, 2014). DASH diet is used as an effective dietary measure to manage hypertension (Sacks and Campos, 2010).

Diet and Cancer

Cancer is the second leading cause of death in developed countries. The immigrant population to the west develops cancers similar to that of the country migrated. Cancers in developing countries is also on the rise with an urban rural divide in the prevalence and types of cancer.

Cancers are both due to external and internal insults resulting in cumulative effects leading to DNA damage/mutations which over a period of time progress to overt cancer manifestations. A detailed discussion of the carcinogenic process is beyond the scope of this article.

The total deaths estimated worldwide were 8.2 million and by 2030, the global burden is expected to grow to 21.7×10^6 (new cancer cases with 13×10^6 deaths-American Cancer Society, 2015). Nearly 25×10^5 of cancer cases are diagnosed and 5.5×10^5 deaths occur annually due to cancer in India (Das and Petro, 2010). The three most prevalent fatal cancers are oral [lip and pharynx, (22.9%)], stomach (12.6%) and lung (including trachea and larynx)-11.4% in men, and cervical (17.1%), stomach (14.1%), and breast (10.2%) in women. Tobacco related cancers represent 42% of male and 18.3 % of female cancer deaths (Dikshit *et al.*, 2012).

The World Cancer Research Fund estimates suggest that between one-fifth and one-fourth of cancers worldwide are related to overweight or obesity, physical inactivity, and/or poor nutrition (WCRF/AICR, 2007). India has lower rates of cancer than the western countries but has very few epidemiological studies, which highlight the role of diets in relation to cancer.

A review of a few studies conducted in India, and Indian migrants in Singapore documented reduced risk for oral, oesophageal, breast, endometrial, cervical cancers with high intake of vegetables, fruits, fish,

eggs and diets high in carotenoids and nutrients such as Vitamins C and E (Sinha *et al.*, 2003). Similar findings were reported in upper aerodigestive cancer (oropharyngeal, larynx and oesophagus) such as reduced intake of vegetables/fruits, pulses, fish and low intakes of β carotene, Vitamins A, B complex, C and selenium. Increased energy intake as a risk factor for breast cancers was also documented (Krishnaswamy and Prasad, 1995). A decreased risk was also noted with higher physical activity for breast cancers and consumption of green tea, turmeric, and basil for stomach cancers. On the other hand betel quid chewing, reverse smoking, consumption of chillies and salted tea enhanced upper aerodigestive cancers (Rajkumar *et al.*, 2003; Nayar *et al.*, 2000). Higher body mass index and intake of saturated fats enhanced risk of ovarian, and breast cancer while dried fish, high temperature foods, chillies and spicy foods increased risk of stomach cancers (Mathew *et al.*, 2000). However all the studies reviewed suffer from inadequate sample size, non-standardized dietary protocols for recall of past intake and imperfect statistical procedures and hence difficult to draw firm conclusions.

Unlike the situation in India, in Western Countries, large prospective cohort studies with more elaborate statistics for arriving at causal effects have been reported. The most authoritative account of cancers at several sites and effects of food, nutrition and PA has been documented (WCRF/AICR, 2007). The evidence based science were gathered from systematic reviews and experts panel opinion. They had identified foods/drinks, obesity/body composition as modifiable exposure factors and global preventive measures applicable to populations and individuals were given (Table 3). A summary of findings, proscriptive and prescriptive approaches for cancer prevention, which can be applied to other chronic diseases as well, are as follows:

1. One should be lean and within the normal range of BMI (18.5-23 for Indians), and should avoid weight gain and increase in waist circumference throughout adulthood. Both over weight and obesity enhance the risk of cancers.
2. PA is as important as diet and Physical activity levels (PAL-total energy expenditure as a multiple of basal metabolic rate) to be maintained >1.6 .

Table 3: Anthropometric parameters, foods, beverages and physical activity on cancer risk

Parameters	Cancers	Risk	
		Reduced	Enhanced
Convincing evidence			
Attained height	Breast-post menopause, Colorectum, Ovary		↑
Abdominal fat	Colorectum		↑
Body fatness	Oeasophagus, Pancreas, Colorectum, Prostate, Endometrium, Breast-post menopause, Kidney		↑
Physical activity	Colorectum, weight gain, OW, OB	↓	
Sedentary living	Weight gain, OW, OB		↑
Lactation	Breast-pre & post Menopause	↓	
Red and processed meat	Colorectum		↑
Aflatoxin	Liver		↑
Arsenic in drinking water	Lung		↑
Alcoholic drinks	Mouth, Pharynx, Larynx, Oeasophagus, Breast-pre & post menopause, Colorectum (men),		↑
β carotene as pharmaceutical supplement	Lung		↑
Probable evidence			
Adult weight gain	Breast- post menopause		↑
Body fatness	Gall bladder, Ovary		↑
Abdominal fatness	Pancreas, Breast-post menopause, Endometrium		↑
Attained height	Pancreas, Breast-pre menopause		↑
Body fatness	Breast-pre menopause	↓	
Being breast fed	Low weight gain, low OW/OB	↓	
Greater birth weight	Breast-pre menopause		↑
Physical activity	Breast-post menopause, Endometrium	↓	
Energy dense foods	Weight gain, OW, OB		↑
Low energy-dense food	Low weight gain , low OW/OB	↓	
Diets high in calcium	Colorectum	↓	
Cantonese style-salted fish	Nasopharynx		↑
Salt, salty foods	Stomach		↑
Diets high in calcium	Prostate		↑
Foods containing fibre	Colorectum	↓	
Non-starchy vegetables	Mouth, Pharynx, Larynx , Oeasophagus, Stomach	↓	
Foods containing folate	Pancreas	↓	
Foods containing lycopene/Selenium	Prostate	↓	
Allium vegetables	Stomach	↓	
Fruits	Mouth, Pharynx, Larynx, Oeasophagus, Lung, Stomach	↓	
Garlic	Colorectum	↓	
Arsenic in drinking water	Skin		↑
Alcoholic drinks	Liver, Colorectum (women)		↑
Mate	Oeasophagus		↑
Sugary drinks	Weight gain, OW,OB		↑

OW – Over Weight; OB – Obesity. Possible and Insufficient evidences are not indicated.

Source: WCIR and AICR, 2007.

3. Energy -dense foods need to be limited and sugary drinks to be avoided. Calorie content should not exceed 125kcal per 100g of food as they promote obesity. Fast foods should be taken sparingly.
4. Foods of plant origin such as non starchy vegetables and fruits (400g/d) with unprocessed cereal grains (unrefined) and legumes (whole grams) must be consumed every day. They provide fiber, phyto and micro nutrients.
5. Individuals must limit the intake of red meat (not more than 300g/person/week) and avoid processed meat.
6. Must avoid mouldy grains/legumes (contains mycotoxins-aflatoxins and others).
7. Salt intake from all sources (cooking salt, salt preserved home foods and processed foods) should not exceed 5-6g/ day (2-2.5 g of sodium).
8. Exclusive breast feeding should be practiced for the first 6 months as it protects both the mother from cancers and the child from future risks of obesity and NCDs.
9. Alcohol intake to be limited (≤ 2 drinks for men and one for women/day as several cancers and other NCDs are aetiologically related to higher intake).
10. Dietary supplements are not recommended for cancer prevention and nutritional supplements for patients to be taken under medical supervision.

Policies and Programs

The rising tide of NCDs is a great public health challenge next only to tobacco consumption needing proactive steps within a broad frame work, impacting common risk factors. (Beaglehole *et al.*, 2011). Dietary patterns may hold great promise in averting NCDs (Mozaffarian, 2016).

WHO, 2014 has set targets to be achieved by 2025 such as a 25% reduction in overall mortality, 10% reduction in prevalence of physical inactivity as also harmful use of alcohol consumption, a 30% reduction in prevalence of tobacco use, 30% reduction

in salt/sodium intake, 25% reduction in high BP and stop the rising menace of obesity and NCDs starting from childhood/adolescent age. A broad integrated framework should include evidence-based strategies cutting across major risk factors including maternal and child under-nutrition to combat dual burden of diseases in India. Comprehensive and coherent approaches involving several players are needed. A strong political commitment, informed health sector, cooperative private sectors and energetic civil societies need to work in consensus to achieve the targets. A focused attention and an enabling environment are essential for individuals, community and populations at large to adopt best measures.

The various policies and programs need to be integrated with advocacy for enhancing awareness among all stakeholders (Krishnaswamy and Laxmaiah, 2011). The government has to be committed and provide resources and merge it with existing infrastructure for sustainability. The following need emphasis to address life styles practices:

1. Food, Nutrition and Agricultural policies to enhance availability, accessibility and affordability of foods to promote Health/ Nutrition.
2. Health policy and programs must concentrate on early detection and treatment and catalyse behavioural changes to promote quality diet and patterns conducive for good physiological and metabolic health. Health system needs a restructuring including primary health care.
3. Pricing, public distribution, excise taxes and incentives are required to enable community to prefer healthy choices.
4. Food laws and legislations to promote healthy diet and ban aggressive promotional strategies and improper/dubious advertisements particularly for children and adolescents.
5. Urban/rural planning with appropriate facilities such as community parks, walking and cycling pathways are essential
6. School health programs have to concentrate on children and adolescents to curtail obesogenic environment and promote physical fitness.

7. Improving canteens in industries and other food service establishments is an important activity.
8. Promote public private partnerships to make available healthy alternative choices of processed foods with mandatory labelling.
9. It is necessary to upgrade nutrition education/ knowledge and build skills in paramedical personnel, empower women, adolescents and children as change agents to facilitate compliance in the community. Social marketing strategies and mass media interventions can play a major role to influence behavioural changes.
10. Dietary and physical activity guidelines need to be formulated and widely circulated.
11. Establish a national multi-sectoral body for planning, guiding, implementing and monitoring activities for prevention and control of NCDs and build capacity at all levels.

Needless to reiterate that political commitment, leadership at several levels and focused approaches are the back bone of any preventive strategy. The Government of India after consultation process with

stake holders has launched a program for prevention and control of cancer, diabetes, CVD, COPD and stroke in 2010. The program is under implementation in 100 districts and is a multi-sectoral plan to cover all districts in a phased manner. The framework has 21 indicators and 10 targets in line with WHO targets with additional inputs to control indoor pollution due to cooking fuel. They are indicated in Fig. 5 (MOHFW, 2013).

Conclusions

Globally NCDs are major causes for morbidity and mortality. NCDs are more challenging in developing countries affecting young people with premature deaths creating innumerable hardships for the family. The NCDs are escalating primarily due to demographic, socioeconomic variations and technological innovations in diverse arena compounded by urbanization, globalization/trade liberalization with strong market forces (mega market chains) promoting consumerism and food culture change.

India is passing through the same wave of drivers (risk factors) for dual burden of diseases imposing a heavy economic burden on the family and health

Fig. 5: Action points to achieve NCDs target 2025

systems. A transition from traditional foods which are minimally processed to refined foods with enhanced intake of sugars, oils, hydrogenated fat ('vanaspati') containing trans-fat, saturated fat, SSBs, animal foods, dairy foods and salty snacks with little awareness has shifted the entire food environment pattern. Moreover whole grains, nuts, pulses and legumes; and vegetables and fruits, which favourably impact disease processes, are not consumed in required quantities. On the other hand processed and convenience snacks, street foods and ready-to-eat meals are on an increase due to taste preferences, availability in supermarkets/fast-food outlets and women choosing to prefer economically remunerative jobs in urban areas slowly eroding traditional household cooking.

CVD, diabetes and cancer are escalating in India and it is essential to accelerate preventive strategies. A massive nutrition education program using diverse strategies and a life course perspective of preventive

steps with emphasis on removing barriers to healthy eating and physical inactivity are essential.

Comprehensive policies and programs on evidence-based sciences that are cost effective and sustainable to address under and over nutrition are essential. Regulatory bodies need to be vigilant exercising their authority to keep unhealthy substances within limits. Public private partnerships must have common goals to promote healthy choices.

The Government of India has embarked on NCD prevention strategy with several actions oriented programs. The program has both primary and secondary prevention covering several risky behaviours. With a strong political commitment and leadership within the Health Ministry, India hopes to win the war against the NCDs, which is multi-factorial in origin and multifaceted in presentation and requires multipronged approach for prevention and control.

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