

**Role of adequate and balanced Nutrition-
Carbohydrates, Fats, Proteins, Dietary Fiber,
Micronutrients**

Dr B Sesikeran MD, FAMS

Former Director

National Institute of Nutrition-

Indian Council of Medical Research- Hyderabad

Balanced diet definition.

A diet that contains the proper proportions of carbohydrates, fats, proteins, vitamins, minerals, and water necessary to maintain good health.

Same as Above with no physical activity ???????

WHO recommendations-1

- A healthy diet helps protect against malnutrition in all its forms, as well as non communicable diseases (NCDs), including diabetes, heart disease, stroke and cancer.

WHO recommendations-2

- Unhealthy diet and lack of physical activity are leading global risks to health.
- Healthy dietary practices start early in life –

WHO recommendations-3

- Energy intake (calories) should be in balance with energy expenditure.
- Evidence indicates that total fat should not exceed 30% of total energy intake
- Shift in fat consumption away from saturated fats to unsaturated fats
- Elimination of industrial trans fats

WHO recommendations-4

- Limiting intake of free sugars to less than 10% of total energy intake is part of a healthy diet.
- A further reduction to less than 5% of total energy intake is suggested for additional health benefits

Women limit added sugar to 100 calories per day or about 6 teaspoons



Men limit added sugar to 150 calories per day or about 9 teaspoons



The average American actually consumes 365 calories per day or about 23 teaspoons



Average Indian ?

(Guideline: Sugars intake for adults and children. Geneva. World Health Organization, 2015



artificial sweeteners ILSI 2015

WHO recommendations-5

- Keeping salt intake to less than 5 g per day helps prevent hypertension and reduces the risk of heart disease and stroke in the adult population
- WHO Member States have agreed to reduce the global population's intake of salt by 30% and halt the rise in diabetes and obesity in adults and adolescents as well as in childhood overweight by 2025.

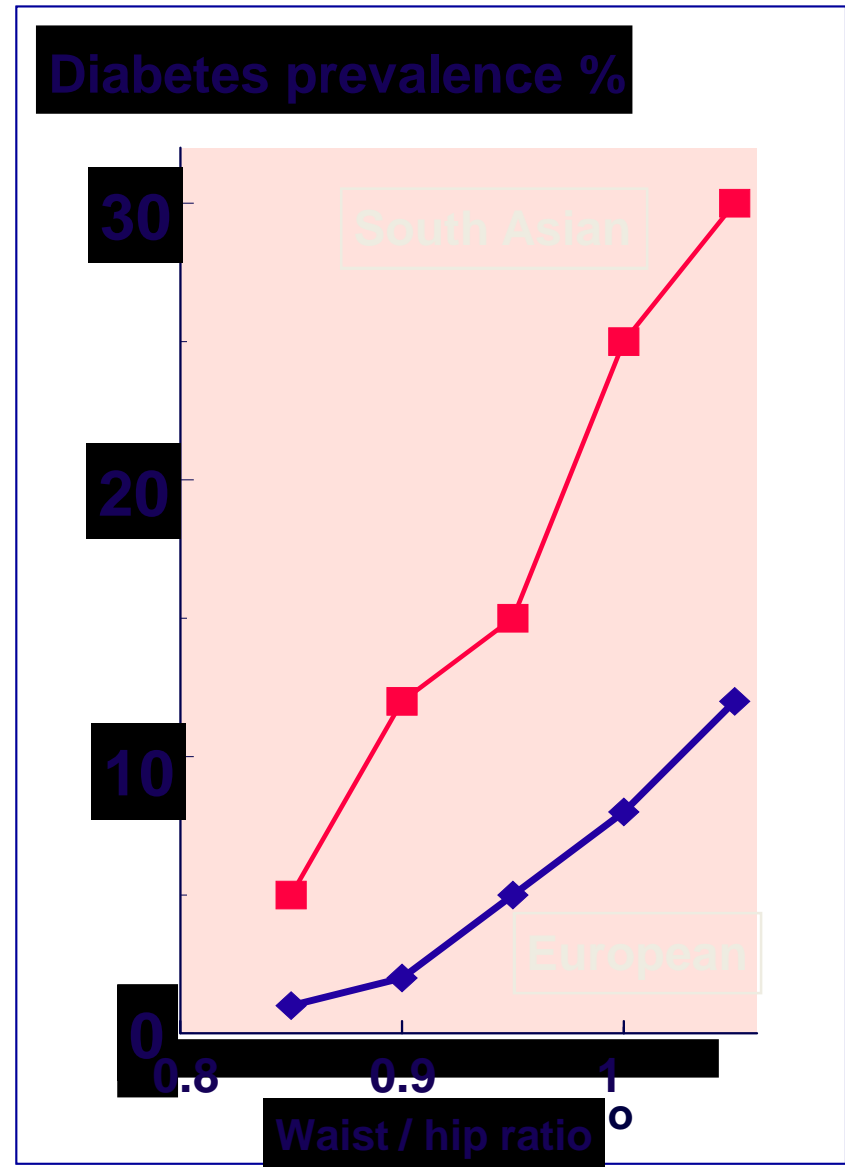
Risk of NCDs greater for Asians

- BMI value > 23.0 Kg/m² – risk of T2DM and CVD increases
- Greater correlation with increasing abdominal circumference / WHR
- Higher percent body fat at the same BMI in Asians.
- Metabolic SYNDROME

Central obesity and insulin resistance: South Asian susceptibility



McKeigue et al. Lancet, 1991, 337: 382



Foci for action in relation to obesity

- **Fats**
- **Sugars**
- **Fruit and vegetables**
- **Physical activity**



TRADITIONAL DIETS

CURRENT DIETS

BULKY

LOW ENERGY DENSITY

SLOWLY DIGESTED

PROTEIN ↑

FAT ↓

UNSATURATED FATS ↑

COMPLEX CARBO- ↑

HYDRATES-FIBRE

VITAMINS / MINERALS ↑

PHYTONUTRIENTS ↑

GLYCEMIC INDEX ↓

Na / K RATIO ↓

CALCIUM ↑

PALATABLE

ENERGY DENSE

RAPIDLY DIGESTED

PROTEIN ↑

FAT ↑

SATURATED FATS ↑

REFINED FOODS ↓

FIBRE

VITAMINS/MINERALS ↓

PHYTONUTRIENTS ↓

GLYCEMIC INDEX ↑

Na / K RATIO ↑

CALCIUM ↓

EVOLUTION AND EXERCISE

The upright bipedal gait	-	Standing / walking
Home sapiens	-	Vigorous exercise
TEE / RMR Hunter gatherer	-	1.8
Modern man	-	1.1
VO² max (Hunter gatherer)	-	52 ml/kg/min
Modern man	-	40.8 ml/kg/min

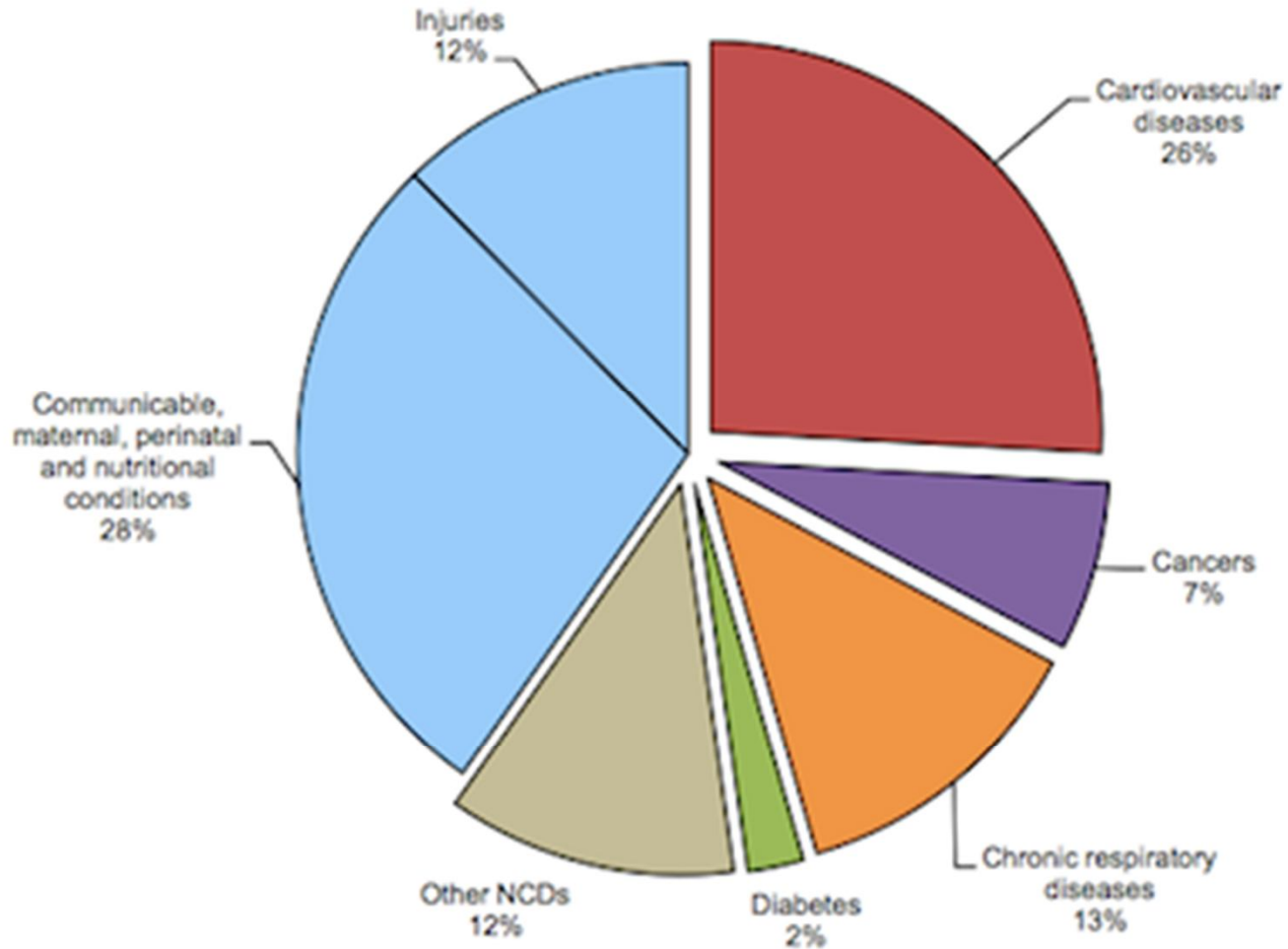
Source :Chen, World Rev. Nutr. Dietet. 84: 106, 1999

Percentage of population living in urban areas: 31.3%

Population proportion between ages 30 and 70 years: 40.1%

WHO
2013

Proportional mortality (% of total deaths, all ages, both sexes)*



Total deaths: 9,816,000

NCDs are estimated to account for 60% of total deaths.

INDIA



Non Communicable Disease Unit

Ministry of Healthcare & Nutrition

According to Registrar Generals data in 2001, in Sri Lanka the non Communicable diseases accounted for 71% of total deaths.

Carbohydrates

Free sugars

- Include mono(Glucose and Fructose) and disaccharides(Sucrose, Lactose and Maltose) added to foods and beverages by the manufacturer, cooks or consumers

(Guideline: Sugars intake for adults and children. Geneva. World Health Organization, 2015



artificial sweeteners ILSI 2015

Free sugars



- Sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates.
- Increase or decrease in consumption of free sugars is associated with a parallel change in body weights.
- **(Guideline: Sugars intake for adults and children. Geneva. World Health Organization, 2015)**

(Guideline: Sugars intake for adults and children. Geneva. World Health Organization, 2015)

- Even in individuals with inadequate energy intakes, increasing the free sugar content of their food is not recommended.
- This excludes therapeutic diets for Severe Acute Malnutrition(SAM) and Moderate Acute Malnutrition (MAM).

Consequences of lowering sugar in food

- Reducing free sugars in foods will greatly impact taste
- Lack of taste is the biggest impediment to compliance for reducing energy intakes.
- If free sugar intakes have to be brought down there is a need for artificial sweeteners

The Good Carbohydrates

Dietary Fiber

- Eat as much as you want
- Satiety is achieved
- Digests slowly – Low GI
- Slows down absorption of Sugars and Cholesterol from other foods
- eg β Glucan(Oats) or Galactomannan(Fenugreek)
- Improves Bowel motility
- Good for Gut bacteria

RDA for Dietary Fiber

- Digestible fiber about 35% adds 50KCals/day
- Estimates of intake

Rural – 35 g/d

Tribal – 17

HIG- 25

LIG- 22.

RDA- WHO 30g . Upto 40g

FATS

OUR LIPID PROFILES

Our Lipid Profiles are Different

- ❖ **High triglyceride.**
- ❖ **Low concentrations of high density lipoprotein (HDL)**
- ❖ **The LDL particle size tends to be smaller (small, dense LDL)**
- ❖ **Small particle size (LDL-3) increases the susceptibility to oxidation**
- ❖ **More atherogenic than the larger ones**

Diet surveys by the National Nutrition Monitoring Bureau show that daily intake of visible fats in rural India range 6-22g

In the urban middle and upper income groups the daily intake of visible fat ranges between 22-45g / p / d and total fat in their diets furnish 20-33%E.

TABLE 6.1. RECOMMENDATIONS FOR DIETARY FAT INTAKE IN INDIA

Age/Sex/ physiological groups	Physical activity	Minimum level of Total fat (%E)	Fat from foods other than visible fats ^g %E	Visible fat ^h	
				%E	g/p/d
Adult Man	Sedentary	20 ^a	10	10	25
	Moderate				30
	Heavy				40
Adult Woman	Sedentary	20 ^a	10	10	20
	Moderate	20 ^b			25
	Heavy				30
	Pregnant women	10	10	30	
	Lactating women			30	
	Infants	0 – 6 months	40-60 ^c	Human milk ⁱ	
7- 24 months		35 ^{c,d}	10 ^e	25	
Children	3-6 years	25 ^{c, f}	10	15	25
	7-9 years				30
Boys	10 – 12 years				35
	13 – 15 years				45
	16 – 18 years				50
Girls	10 – 12 years				35
	13 – 15 years	40			
	16 – 18 years	35			

Reference ^a6.5 ^b 6.11 ^c 6.9

^d gradually reduce depending on physical activity ^e Human milk /infant formula+ complementary foods

^f depending on physical activity, ^g if higher than 10%E, visible fat requirement proportionately reduces

^h cooking oils, butter, ghee and margarine

ⁱ infant formulae/ milk substitutes should mimic contents of fat and fatty acids in human milk including arachidonic and docosahexaenoic acid.

Table 6.2**Approximate fatty acid composition of dietary fats and oils consumed in India (% of total fatty acids)**

Fats/ oils	SFAs*	MUFAs**	LA	ALA
High (medium chain) SFAs				
Coconut	92 ^{a, d}	6	2	-
Palm kernel	83 ^{b, d}	15	2	-
Butter/Ghee	68 ^{c, e, f}	29	2	1
High SFAs & MUFAs				
Palmolein	39	46	11	<0.5
High MUFAs & Moderate LA				
Groundnut ⁱ	19	41	32	<0.5
Rice bran ^h	17	43	38	1
Sesame ^h	16	41	42	<0.5
High LA				
Cottonseed ^h	24	29	48	1
Corn ^h	12	35	50	1
Safflower ^h	9	13	75	-
Sunflower ^h	12	22	62	-
LA & ALA				
Soybean ^h	14	24	53	7
Canola ^h	6	60 ^j	22	10
Mustard/rapeseed ^h	4	65 ^k	15	14
Flaxseed	10	21	16	53
High TFAs				
Vanasapti ^h	46	49 ^g	4	-

TABLE- 6.5 RECOMMENDATIONS FOR TYPE OF VISIBLE FAT #

<p>1.</p>	<p>Use correct combination / blend of 2 or more vegetable oils (1:1)##</p> <p><i>Oil containing LA + oil containing both LA and ALA (Table 6.1, Columns 8 & 9)*</i></p> <p>Groundnut / Sesame^a / Rice bran^b / Cottonseed + Mustard/ Rapeseed ** Groundnut /Sesame^a / Ricebran^b / Cottonseed + Canola Groundnut / Sesame^a / Rice bran^b / Cottonseed + Soyabean Palmolein^c + Soyabean Safflower / Sunflower + Palm oil/Palmolein^c + Mustard/ Rapeseed**</p> <p><i>Oil containing high LA + oil containing moderate or low LA *** Table 6.4 Column 8)</i></p> <p>Sunflower / Safflower + Palmolein^c / Palm oil^c / Olive Safflower / Sunflower + Groundnut / Sesame^a / Ricebran^b / cottonseed</p>
<p>2.</p>	<p>Limit use of butter/ghee ^d (Table 6.1, Column 2)</p>
<p>3.</p>	<p>Avoid use of PHVO as medium for cooking / frying (Table 6.1 columns 2 & 4)</p>
<p>4.</p>	<p>Replacements for PHVO (Table 6.1, column 4)</p> <p>Frying : oils which have higher thermal stability -- palm oil^c / palmolein^c, sesame^a, ricebran^b, cottonseed -- single / blends (home /commercial)</p> <p>Bakery fat, shortening, Mithai / Indian sweets etc -- Food applications which require solid fats : coconut oil/ palm kernel oil/ palm oil / palmolein/ palm stearin and / their solid fractions and / their blends</p>

Volk et al Plos One 2014

- Dietary Sat Fat intake and plasma Sat Fat are not related
- Increasing dietary CHO over a range of intakes promotes an incremental change in plasma Palmitoleic acid – a biomarker of adverse health outcomes

PUFA Intake in different populations (gm/d)

Population	n-6	n-3	n-6/n-3
India	20	0.5	40
USA	14	1.4	10
UK	14	1.9	7
Japan	26	7.0	4
Eskimo	5	5	1

n3 Advantages in CVD

- Reduces risk of cardiac arrhythmias
- Reduces platelet adherence and risk of thrombosis
- Anti Inflammatory effect- reduces CRP
- Inhibits cardiovascular calcification

Table 6.7 Approximate Quantity of Foods Required to Furnish 0.1 g n-3 PUFAs

Plant Foods (ALA)	g	Vegetable oils (ALA)	g
Cereal /Millet Wheat , Bajra Oats (germ) Wheat (germ)	70 70 1.4	Mustard / Rapeseed Soyabean Canola Flaxseed	0.7 1.5 0.5 0.2
Pulses Black gram, Rajmah & Cow pea Soyabean Other pulses	20 7 60	Animal foods (LCn-3PUFAs) Fish^b Low / medium fat fish ^c Oily fish ^d (>5 % fat)	20-50 10
Vegetables Green leafy Purslane ^a Radish seed (sprouted) Spirulina (dried)	60 25 14 12		
Spices Fenugreek Seed Mustard Seed	5 2	Poultry Egg Standard ^e DHA enriched(flaxseed) ^{f,g} DHA enriched (fish meal) ^g Chicken ^h	2-3 eggs 1 egg 1/3rd egg 100
Nuts Walnuts Almonds	2 25	Lean meats Lamb, sheep, goat, beef, pork ⁱ	150
		Fish oils Cod liver ^j Muscle oil	0.5 0.3
Unconventional oilseeds Flaxseed (linseed) Perilla seed	0.5 0.5	Algal oil based DHA products	To see contents on label

Dietary Cholesterol

- There is insufficient evidence to determine whether lowering dietary cholesterol reduces LDL-C.

Abstract. Willett WC . Dietary fats and coronary heart disease (Review). J Intern Med 2012; 272: 13–24

- All lines of evidence indicate that specific dietary fatty acids play important roles in the cause and the prevention of CHD, but total fat as a percent of energy is unimportant.
- Trans fatty acids from partially hydrogenated vegetable oils have clear adverse effects and should be eliminated.
- Modest reductions in CHD rates by further decreases in saturated fat are possible if saturated fat is replaced by a combination of poly- and monounsaturated fat, and the benefits of polyunsaturated fat appear strongest

Little or no benefit if SFA is replaced by carbohydrate, but will in part depend on the form of carbohydrate.

N-6 and N-3 PUFA are essential and reduce risk of heart disease

Ratio of N-6 to N-3 is not useful and can be misleading.

Reducing red meat and dairy products and increasing intakes of nuts, fish, soy products and nonhydrogenated vegetable oils will improve the mix of fatty acids and have a markedly beneficial effect on rates of CHD.

Fat and Insulin Resistance

- Oleic acid (MUFA) may promote Insulin resistance while PUFA does not (FAO/WHO : Fats and Fatty acids in human nutrition: report of an expert consultation; FAO/WHO Geneva Switzerland, 2010)

Protein Intakes

- Deceptively high even in LIG due to high cereal intakes- poor quality
- Quality depends on 1. Digestibility and 2. Amino Acid Scores
- PDCAAS – Milk and Egg protein – 100
- Cereal and Pulse proteins – less digestible and missing amino acids- Lysine in cereals/ Methionine in Pulses

Protein Quality of Cereal Pulse combination

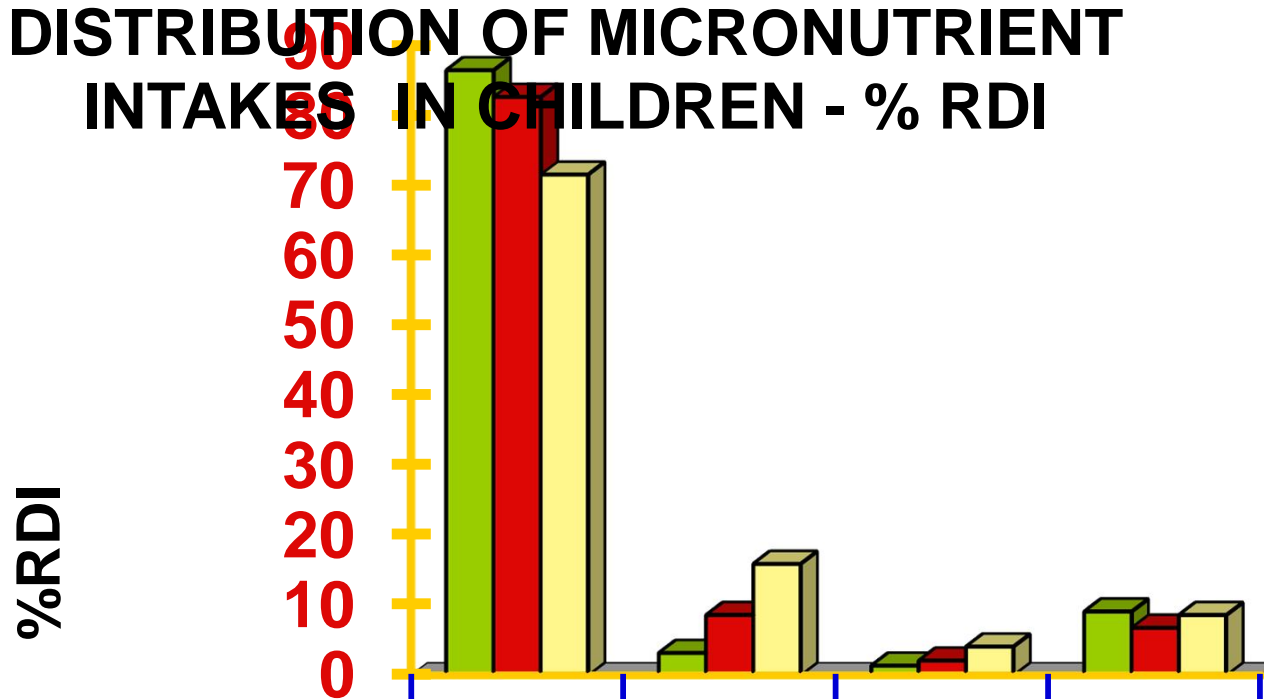
- Cereal:Pulse generally 5:1
- PDCAAS is 65% vs Egg 100%
- High level of dietary fiber decreases protein digestibility
- Protein Digestibility (PD) in Veg Diets with milk is 85%
- Amino acid score is mg of amino acid in test protein/ mg of AA in ref protein
- PDCAAS= PD X AAS

Protein RDA

- FAO/WHO recommends individual AA RDAs
- Daily Protein requirement calculation:
 1. Level for age group per kg
 2. Multiply requirement per Kg B Wt by Wt for Age
 3. RDA for Veg diet 0.8 to 1.0 g/Kg B wt/ Day

Micronutrients

DISTRIBUTION OF MICRONUTRIENT INTAKES IN CHILDREN - % RDI



	<70	70-90	90-100	>100
■ Vitamin A	86.3	3.2	1.4	9.1
■ Iron	82.5	8.6	2.1	6.8
■ Riboflavin	71.4	15.9	4.1	8.6

Micronutrient Deficiency Disorders of Public Health significance:

- Iron Deficiency Anaemia (IDA)***
- Vitamin 'A' Deficiency (VAD) and***
- Iodine Deficiency Disorders (IDD)***
- Vitamin D Deficiency***
- Folic Acid and Vitamin B 12***

Vitamin - D Deficiency

Prevalence of VDD - Indian studies

Studies	Cut off point	Prevalence %
Delhi, Madhava Rao, Goswami, Adults-2006	< 20 ng/ml	94.3%
Seema Puri et al Adolescent girls	< 20 ng/ml	90.8%
Pregnancy, Term NIN study, 2008	< 20 ng/ml	51.8%
Cord blood, NIN, 2008	< 20 ng/ml	91%
Alok sachan et al pregnancy	< 10 ng/ml	42.5%
Harinarayan et al Tirupati, children	< 20 ng/ml	75%

Advantages & Disadvantages of Various Strategies

STRATEGY	ADVANTAGES	LIMITATIONS
Short Term (Nutrient Supplementation)	Immediate Benefit Very Effective, if properly implemented.	Expensive, Needs Manpower, Inadequate/Irregular Supplies, Inadequate/Irregular Coverage, Non-compliance, Not Sustainable.
Long Term (Nutrition Education/ Dietary Diversification)	Desirable, Sustainable, No cost involved.	Difficult to achieve, Time consuming.
Medium Term (Food Fortification)	Easy, Cost effective, Good compliance, Sustainable, Easy to Regulate.	Risk due to several foods being fortified

Fetal Origins of Adult Onset Diseases





EPIGENETIC MECHANISMS

are affected by these factors and processes:

- **Development** (in utero, childhood)
- **Environmental chemicals**
- **Drugs/Pharmaceuticals**
- **Aging**
- **Diet**

HEALTH ENDPOINTS

- **Cancer**
- **Autoimmune disease**
- **Mental disorders**
- **Diabetes**

CHROMOSOME

CHROMATIN

METHYL GROUP

EPIGENETIC FACTOR

DNA

DNA methylation

Methyl group (an epigenetic factor found in some dietary sources) can tag DNA and activate or repress genes.

HISTONE TAIL

GENE

HISTONE TAIL

DNA accessible, gene active

HISTONE

DNA inaccessible, gene inactive

Histone modification

The binding of epigenetic factors to histone "tails" alters the extent to which DNA is wrapped around histones and the availability of genes in the DNA to be activated.

Histones are proteins around which DNA can wind for compaction and gene regulation.

Maternal nutritional status can alter the epigenetic state of the fetal genome and imprint gene expression.

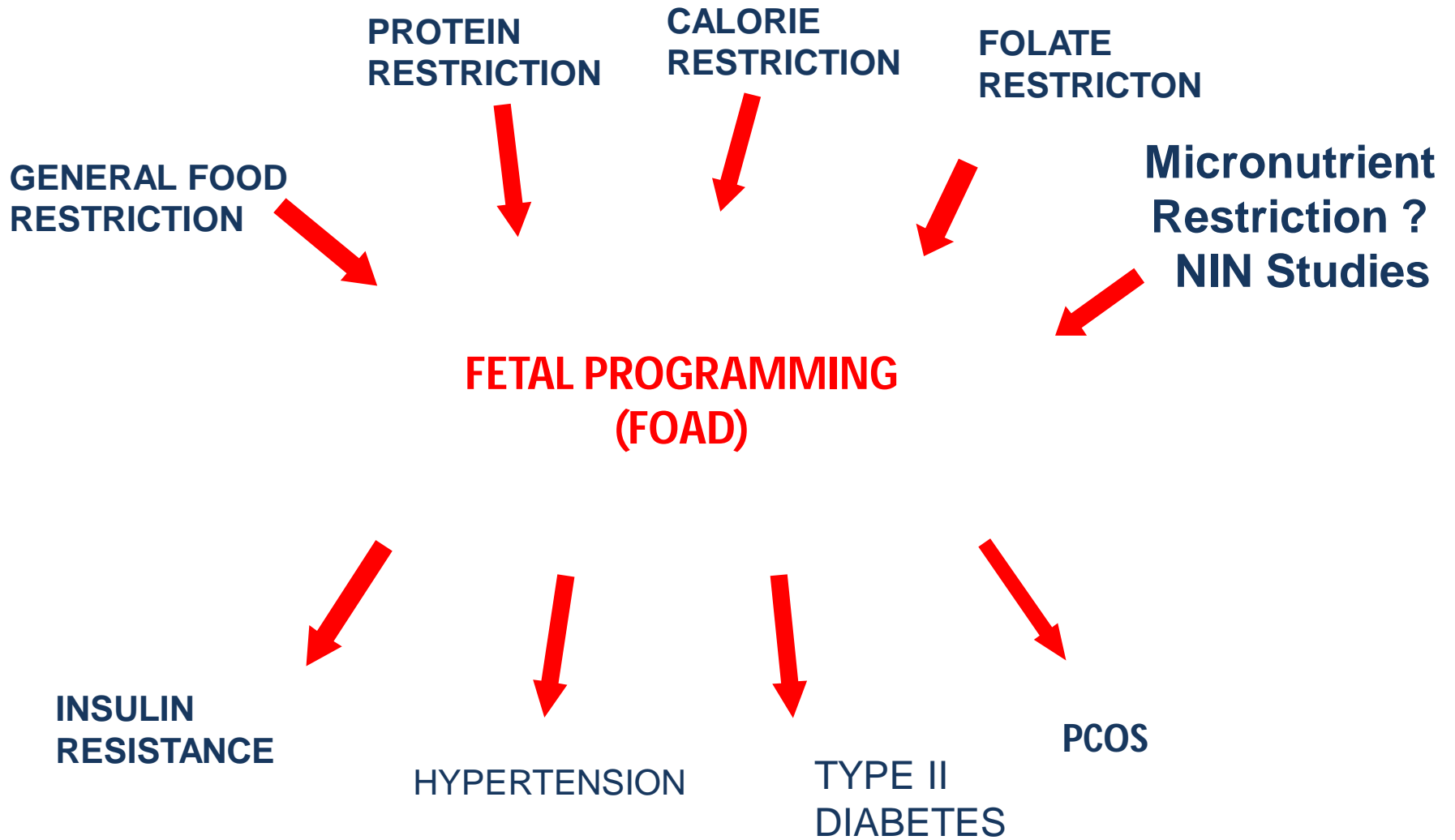
Factor 1 – DNA methylation

Factor 2 – Histone acetylation and Methylation

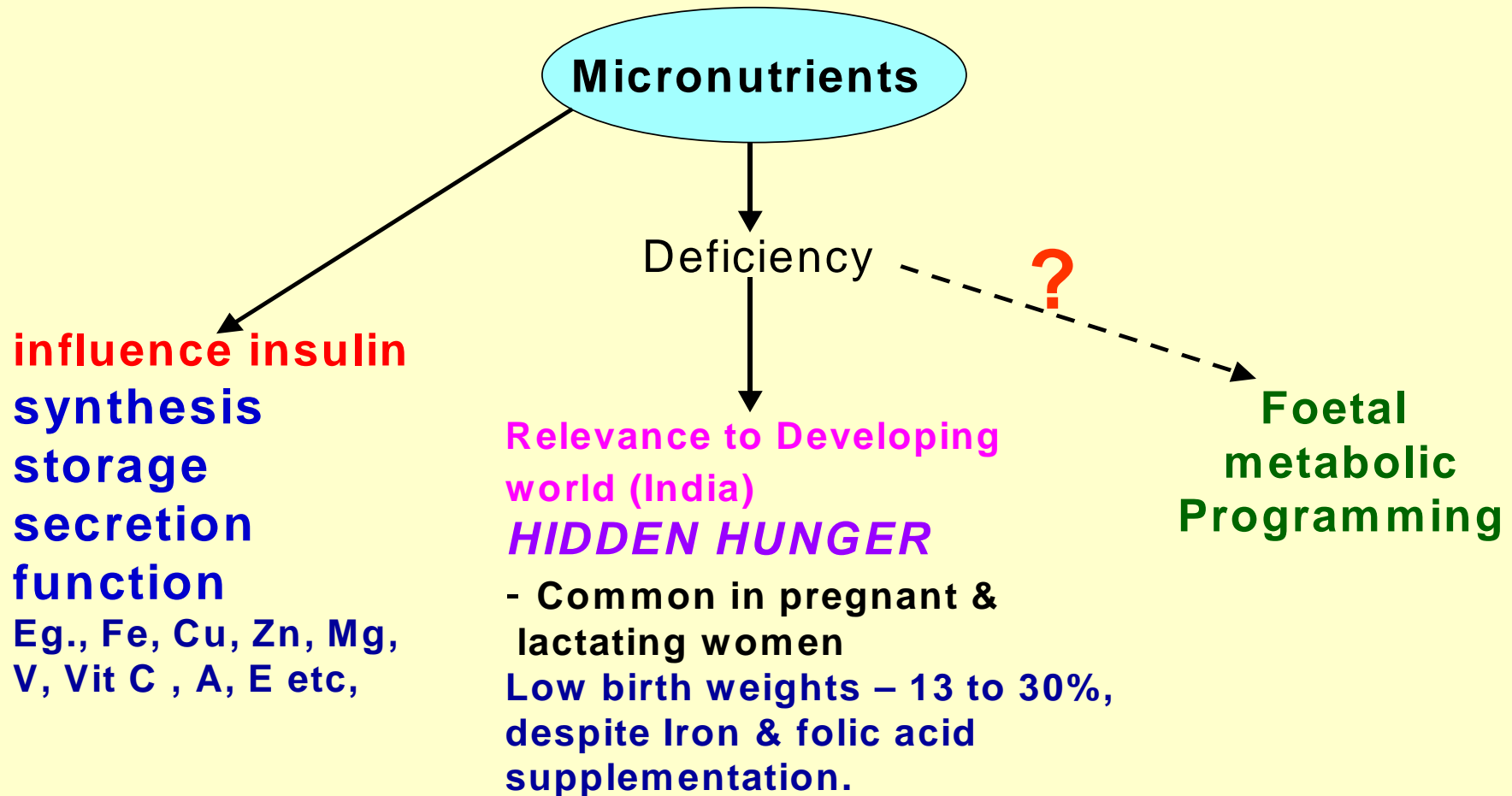
Both are affected by availability of Amino Acids and Micro nutrients like B12, Folate and B6

These changes affect Fetus, Placenta, and tissues —
blood vessels, pancreas, kidney etc

MATERNAL RESTRICTIONS AND FOAD



Fetal programming and micronutrients



Research in India

- Low birthweight children have increased CVD risk factors
Delhi birth cohort - low infant weight, and rapid childhood weight gain, increase the risk of type 2 diabetes.
- Pune Maternal Nutrition Study, low maternal vitamin B12 status predicted increased adiposity and insulin resistance in the children, especially if the mother was folate replete.
- Recent intervention studies in several developing countries have shown that CVD risk factors in the offspring can be improved by supplementing undernourished mothers during pregnancy.

Fall: ijmr 2010

Hyderabad Study

- Among adolescents , whose pregnant mothers received food-based energy and protein supplements as part of a package of public health interventions(ICDS)
- Insulin resistance and arterial stiffness were lesser compared to controls (kinra et al BMJ 2008)

Nepal Study

- Systolic blood pressure was lower (-2.5 mmHg) in 2-yr old Nepali children whose mothers received multiple micronutrients in pregnancy rather than standard iron/ folate tablets (Vaidya et al Lancet 2008)

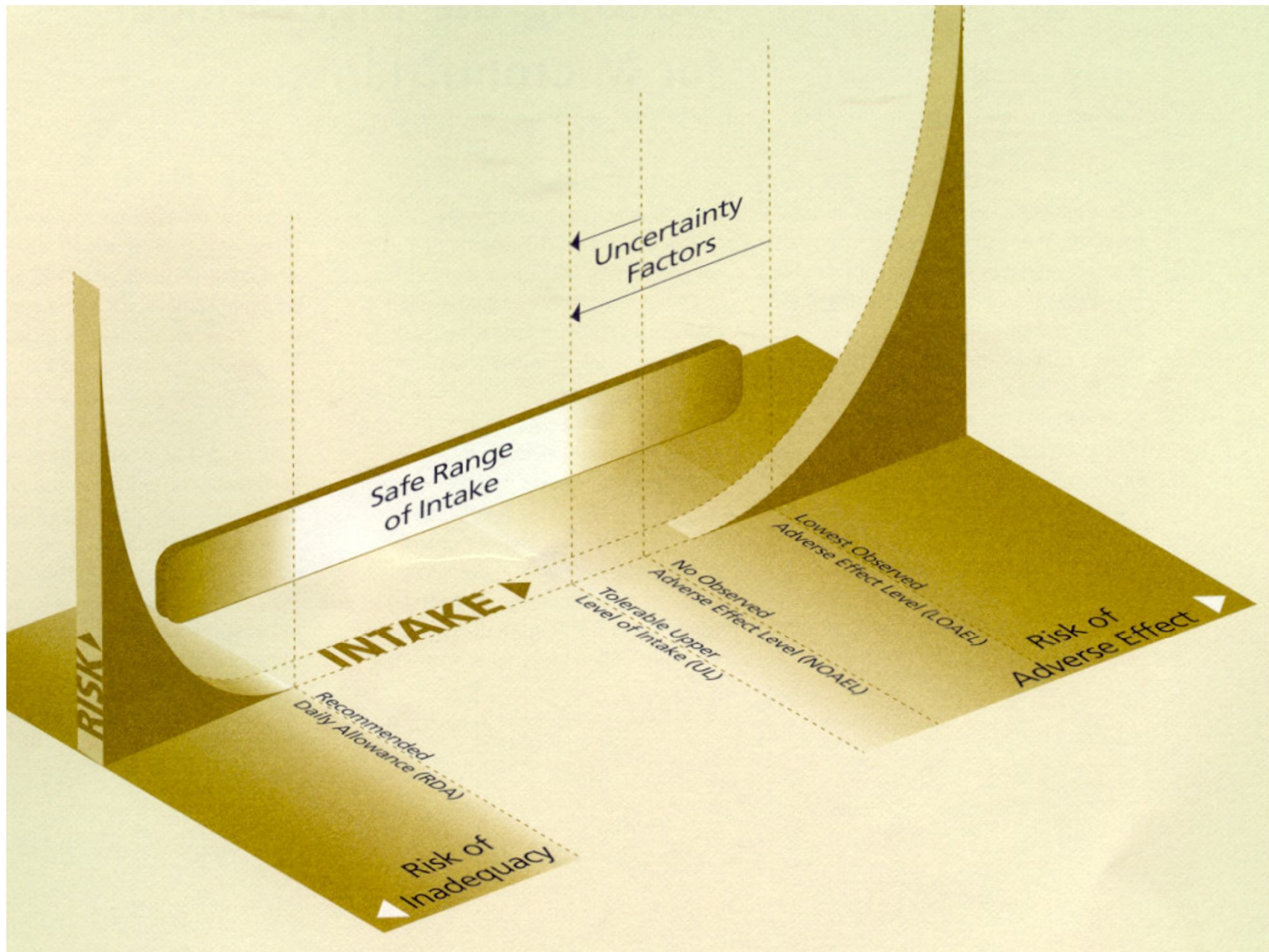
Role of Placenta

- The size, morphology, and nutrient transfer capacity of the placenta determine the prenatal growth trajectory of the fetus to influence birth weight.
- Transplacental exchange depends on uterine, placental, and umbilical blood flow.
- Role of Arginine and Nitric Oxide
- Belkacemi et al *biol repro* 2010

Summary

- Energy and Protein restrictions reduce birth weights but minimal
- Micronutrient deficiencies result in significant impact
- Multiple MN supplementation improve birth weights
- Foetal growth is related to maternal height and birthweight.
- Undernutrition of the mother during her own foetal life and childhood growth limits the growth of her foetus.
- Effects of the mother's current nutritional status are influenced by her own past nutrition and that of earlier generations.

(Fall IJMR 2010)



- ❖ Reference Labeling Value (RLV) – RDA value for labeling purposes
- ❖ Upper Limit (UL)

Evidences

- There is as yet no evidence as to which dietary supplements reduce the risk of chronic diseases like CVD and Cancer
- There could be some supplements which may increase the risk
- (Schwingshaki et al ; Syst Rev 2015)
- Supplements are not recommended in the treatment of cancer



Thank you