

Micronutrients

Defining Nutrient Needs

What is deficiency? Lack or shortage of a functional entity, by less than normal or necessary supply or function.

What is toxicity?

- Toxicity is the degree to which a substance can damage an organism
- A central concept of toxicology is that effects are dose dependent
- Toxicity is species-specific, making cross-species analysis problematic

What is bioavailability?

- The fraction (or percentage) of nutrient absorbed that is useful to the body
- The degree to which an absorbed nutrient is available to the system
- Basic law in Nutrition: No nutrient is absorbed and utilized to the full extent that it is fed

Dietary Reference Values (DRV): Denoted on packages of cereals. These are the intakes of nutrients which are required to maintain balance in the body. Concept of optimal nutrition (maximizes physiological / mental function and minimizes development of degenerative diseases). Latter concept difficult because interactions, physiological situations, genetic variability.

NOAEL: no observed adverse effect level. Highest intake level at which no effects of overdosing are observed

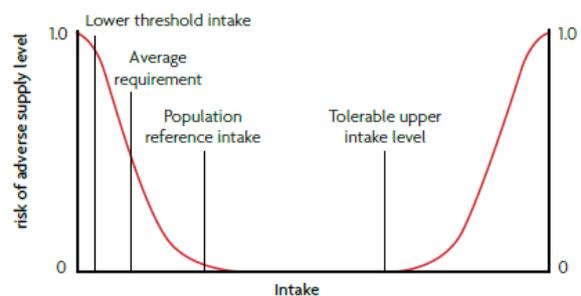
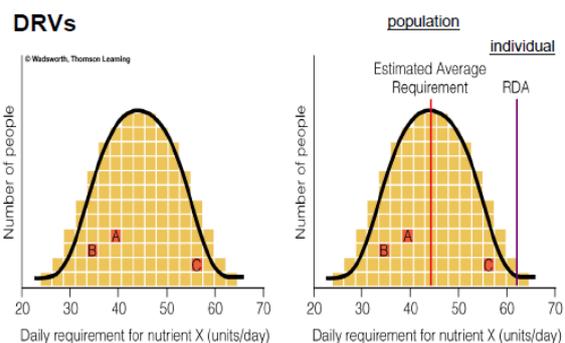
LOAEL: lowest observed adverse effect level. Lowest intake level at effects of overdosing are observed

Characteristics of the DRVs:

- Separate values:
 - gender
 - age
- Apply to healthy individuals
- Refer to average daily nutrient intakes
- May vary substantially from day to day without ill effect in most cases

Purposes of DRVs:

- To maintain nutritional adequacy
- To promote health
- To support legal actions – see food labels
- To reduce risk of chronic disease
- To provide a measure for evaluating inadequacy and/or excess
- To assess intakes as distributions
 - Across population groups
 - In individuals
- To plan diets



Vitamins

- Vitamins: vital "amins" → essential to life, required for...

- Growth
- Maintenance
- Regulation of body processes
- Vitamins differ from macronutrients
 - Structure
 - Function - no energy yielded
- Required in very small amounts (mg or µg) – different from essential fatty acids & essential amino acids
- Solubility (water vs fat)
- Can be destroyed during storage and in cooking
- Roles of Vitamins
 - Vitamins are organic compounds that perform chemical functions in the body
 - Most metabolic processes require vitamins (many coenzymes are composed of vitamins)
 - Vitamins control processes of tissue/cellular synthesis (haematopoiesis, bone,...)
 - Because vitamins are organic they can be destroyed and left unable to function (heat, freeze, light, oxygen, water solubility)
 - The body needs vitamins in small amounts but in a regular basis.
- All vitamins are metabolically essential but not all required in the diet
- Fat-soluble (4 fat soluble)
 - Vitamin A
 - Vitamin D
 - Vitamin E
 - Vitamin K
- Water-soluble (9 water soluble: 8 B vitamins & C)
 - Thiamin B₁
 - Riboflavin B₂
 - Niacin B₃
 - Pantothenic acid B₅
 - Pyridoxine B₆
 - Biotin B₇
 - Folate B₉
 - Vitamin B₁₂
 - Vitamin C
- Fat-soluble vitamins
 - Found in fats and oils of foods
 - After absorbed enter lymph, then blood
 - Protein carriers for transport
 - Stored (fatty tissue / liver)
 - Not needed as regularly (weekly or monthly, because stored)
 - Deficiencies slow to develop because stored
 - Toxicities more likely because stored
 - Precursors
 - Fecal excretion
- Water-soluble vitamins
 - Found in watery parts of foods
 - After absorbed move directly into blood
 - Transported freely into blood
 - Transported freely in blood
 - Not stored
 - Needed regularly (every 1-3 days)

- Deficiencies fast to develop because not stored
- Toxicities less likely (large amounts can overwhelm)
- Usually no precursors
- Urine excretion
- Normally, a well-balanced diet will provide enough vitamins → variety of foods

Fat-soluble vitamins

Vitamin A is fat-soluble vitamin needed for the normal structure and functioning of the cells in the skin and body linings, e.g. in the lungs. This vitamin also helps with vision in dim light, as well as keeping the immune system healthy. Further for reproduction and gene expression.

It is found in two forms; retinol in foods from animal sources and carotenoids (the most abundant of which is the beta-carotene) from plant sources. Vitamin A – retinol is found in liver and whole milk, Vitamin A – carotenoids are found in dark green leafy vegetables, carrots and orange coloured fruits.

Vitamin D is needed for the absorption of calcium and phosphorous from foods, to keep bones healthy. Recent research also suggests that vitamin D enhances immune function and improves muscle strength. Vitamin D is found in the diet, but most of our vitamin D is made in the body the action of ultra violet rays on the skin.

Vitamin D occurs naturally in some animal products, including fish liver oils, oily fish, egg yolk, and butter. Cereals, margarine and low fat spreads are also fortified with vitamin D.

Vitamin E is a group of similar molecules with common properties and functions. Vitamin E acts as an antioxidant and protects cells in the body against damage & promotes normal growth and development. Vitamin E is mainly found in vegetable oils, nuts, seeds and wheat germ.

Vitamin K is needed for normal clotting of blood and is also required for normal bone structure. Infants are given vitamin K at birth. Vitamin K is also produced by the bacteria in the gut.

Vitamin K is found in green leafy vegetables e.g. broccoli, lettuce, cabbage, spinach and meat and dairy products.

Water-soluble Vitamins

Vitamin C (Ascorbic acid) is needed to make collagen which is required for the normal structure and function of body tissues, such as skin, cartilage and bones. It also acts as an antioxidant that protects the body from damage by free radicals.

Sources of ascorbic acid include fresh fruits, especially citrus fruits and berries, green vegetables, peppers and tomatoes. Ascorbic acid is also found in potatoes (especially in new potatoes).

Vitamin B was originally thought to be one vitamin (consists of 8) and functions as coenzymes and many additional functions.

Vitamin B is mainly found in grain, fruits meats and milk.

Thiamin (B1) is needed for the release of energy from carbohydrate. It is also involved in the normal functioning of the nervous system and the heart.

Thiamin is mainly found in whole grains, nuts, meat (especially pork), fruit and vegetables and fortified cereals.

Riboflavin (B2) is needed for the release of energy from carbohydrate, protein and fat. It is also involved in the transport and metabolism of iron in the body and is needed for the normal structure and function of skin and body linings.

Riboflavin is found in milk, eggs, rice, fortified breakfast cereals, liver, legumes, mushrooms and green vegetables.

Niacin (B3) is important for releasing energy from food, and is important for the normal structure of the skin and body linings. Niacin is also needed for the normal functioning of the nervous system.

Niacin can be found in meat, wheat and maize flour, eggs, dairy products and yeast.

Pyridoxine (B6) is involved in the PLP and PMP complexes in AA & glycogen metabolism, as well as in AA anabolism and erythrocytes production.

Pyridoxine can be found in meat, potatoes, legumes and fruits.

Folate (B9) is important for the formation of healthy red blood cells. It is also needed for the nervous system and specifically for the development of the nervous system in unborn babies. It can reduce the risk of neural tube defects in a fetus, e.g. spina bifida.

Good sources of folate include green leafy vegetables brown rice, peas, oranges, bananas and fortified cereals.

Vitamin B12 is needed for the formation of red blood cells and the normal functioning of the nervous system. Vitamin B12 also helps to release energy from food.

Vitamin B12 is found exclusively in animal products. It is found in meat, fish, cheese, eggs and fortified breakfast cereals.

Minerals

Calcium (Ca²⁺) is important for the formation and maintenance of strong bones and teeth, as well as the normal functioning of nervous system and muscles. It is also involved in blood clotting.

Milk and dairy products are the most important sources of calcium. Other sources include bread, calcium enriched soya products, green leafy vegetables and fish with soft edible bones.

Phosphorus (P) is engaged in mineralisation of bones and teeth and is part of the genetic material and phospholipids. It functions in energy metabolism and maintaining acid-base balance.

All animal tissues serve as food sources.

Magnesium (Mg²⁺) serves i.a. in replication and translation as well as in proofreading of DNA and RNA.

It is found in nuts, legumes, chocolate, whole grains, dark-green vegetables and bananas.

Chloride (Cl⁻) maintains normal fluid & electrolyte balance and is part of the digestion in the stomach.

It is enriched in table salt, soy sauce, most processed foods and moderate amounts in meats, milk, eggs.

Potassium (K⁺) maintains normal fluid & electrolyte balance, supports cell integrity and is involved in nerve impulse transmission & muscle contraction. It is found nearly everywhere.

Sodium (Na⁺) maintains normal fluid & electrolyte balance and blood pressure. It assists in nerve impulse transmission & muscle contraction.

It is found where chloride is found, too.

Chromium (Cr³⁺) enhances insulin action and may improve glucose tolerance.

It is mainly taken from meats, whole grains and brewer's yeast.

Copper (Cu²⁺) is necessary for the absorption and use of iron in the formation of haemoglobin. It is part of several enzymes and helps to form collagen.

Mainly found in seafood, nuts, seeds, legumes, whole grains.

Fluoride (F⁻) maintains health of bones and teeth and helps to make teeth resistant to decay.

Fluoride is enriched in fluoridated water, tea and seafood.

Iodine (I⁻) is a component of two hormones regulating growth, development and metabolic rate. Its major source is iodised table salt, seafood, bread, dairy products, plants grown in iodine-rich soil.

Iron (Fe^{2+/3+}) is an essential component of haemoglobin, myoglobin and is necessary for the utilisation of energy (cytochromes).

Iron is mainly provided by animal foods but also by plants (non-heme iron; more difficult to absorb).

Manganese (Mn²⁺) has its major role as a cofactor for many enzymes and in bone formation.

It's mainly found in nuts, whole grains, leafy vegetables and tea.

Molybdenum (Mo⁶⁺) acts as cofactor for several enzymes.

Sources are legumes, cereals and nuts.

Selenium (Se⁴⁺) functions as an antioxidant and regulates thyroid hormone.

Food sources are seafood, meat, whole grains, fruits, vegetables.

Zinc (Zn²⁺) has its major roles in enzymes, insulin, genetic material, tissue growth / repair, immune reactions, taste perception, sperm production, fetal development.

Zinc is mainly provided by red meats, shellfish, whole grains and some cereals.

Sulfur (S) functions as part of proteins, vitamins and insulin.

Its main source is all protein containing foods.

Further (essential) elements are nickel, silicon, cobalt, boron and vanadium.