Iodine deficiency disorders

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Outlines

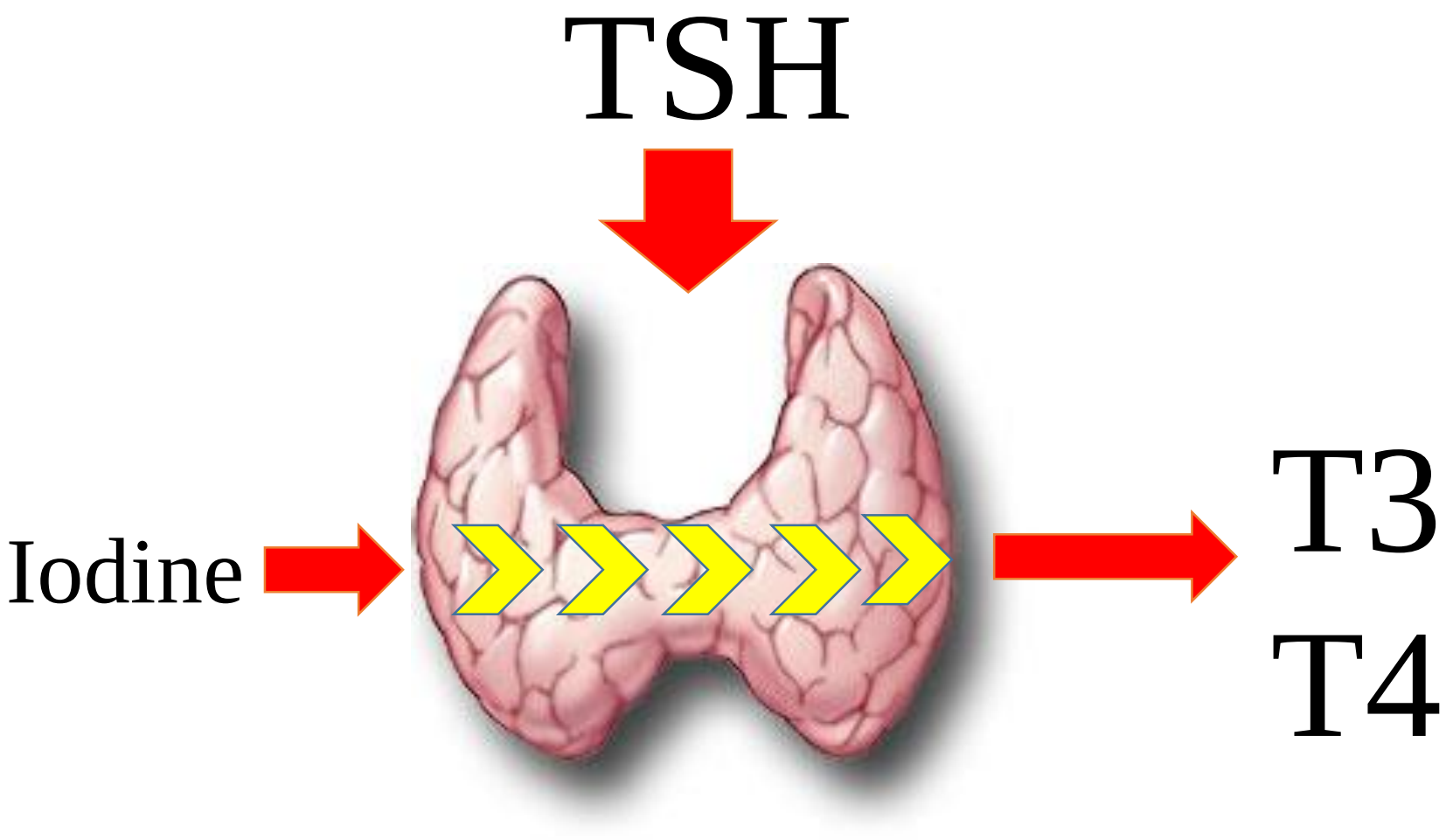
- Definition of IDDs
- Role of iodine in the body
- Consequence of iodine deficiency
  - Fetus
  - Children
  - Adults
- Conclusion

IDD: Iodine Deficiency Disorders

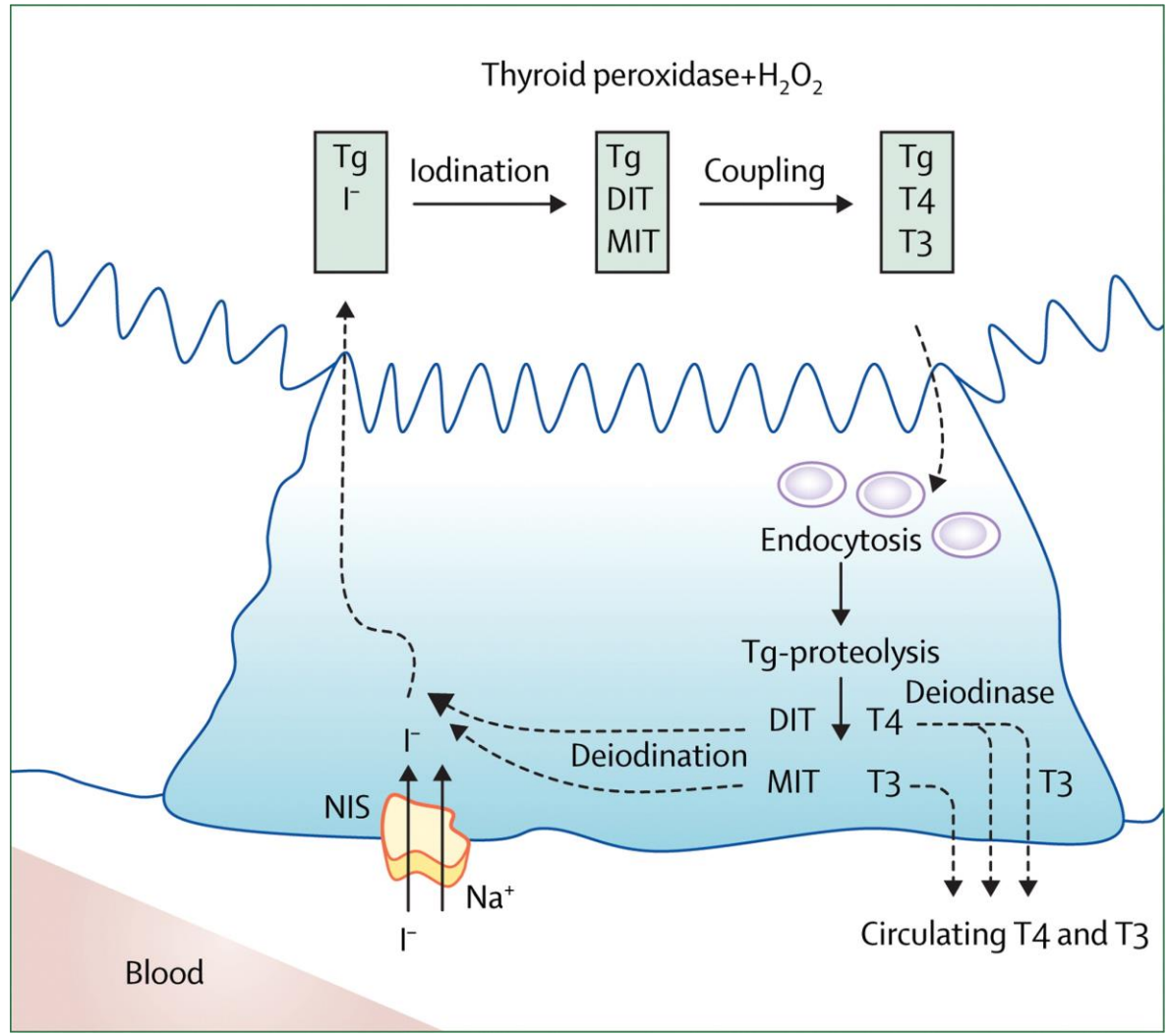
- The world’s most common endocrine problem
- The most preventable cause of mental retardation
- The easiest of the major nutritional deficiencies to correct

Iodine

- Iodine is a chemical element occurs in a variety of chemical forms
- Iodine is an essential trace element for the human
- Iodine is an essential part of the chemical structure of thyroid hormones
- Total quantity (15-20 mg) present in the body, mostly in thyroid gland
- Iodine contributes 65% of T4 and 59% of T3 molecular weight



Thyroid Hormone Synthesis


Thyroid peroxidase+H_2O_2
Tg
I^-
Iodination
Tg
DIT
MIT
Coupling
Tg
T4
T3
Endocytosis
Tg-proteolysis
Deiodinase
DIT
T4
Deiodination
MIT
T3
T3
I^-
NIS
Na^+
I^-
Blood
Circulating T4 and T3

Classification of Goiter (WHO classification)

Grade 0	No palpable, no visible goiter
Grade 1	A goiter that is palpable but not visible when the neck is in the normal position.
Grade 2	A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated.

Recommended daily intake of Iodine

Preschool children	90 μg
Schoolchildren (6-12 y)	120 μg
Adult (>12 y)	150 μg
Pregnant & Lactating women	250 μg

Iodine sources

- Most of the iodine ingested by humans comes from food of animal and plant origin
- This iodine in turn, is derived from the soil
- Only a relatively small fraction is derived from drinking water
- Worldwide soil distribution of iodine is extremely variable & food grown in areas of low iodine does not contain enough of the mineral to meet requirements

Iodine Deficiency:

- Has multiple adverse effects on growth and development in humans, collectively termed as the 'Iodine Deficiency Disorders' (IDDs)

Epidemiological criteria for assessing iodine nutrition in a population based on median and/or range of urinary iodine concentrations

Median urinary iodine (µg/L)	Iodine intake	Iodine nutrition
School-aged children		
<20	Insufficient	Severe iodine deficiency
20-49	Insufficient	Moderate iodine deficiency
50-99	Insufficient	Mild iodine deficiency
100-199	Adequate	Optimal
200-299	More than adequate	Risk of iodine-induced hyperthyroidism in susceptible groups
>300	Excessive	Risk of adverse health consequences (iodine-induced hyperthyroidism, autoimmune thyroid disease and hypothyroidism)

Adaptation to iodine deficiency

- Increased thyroid clearance of plasma inorganic iodine
- Hyperplasia of the thyroid and morphologic abnormalities
- Changes in iodine stores & Tg synthesis
- Enrichment of thyroid secretion in T3
- Enhanced peripheral conversion of T4 to T3
- Increased TSH production

Thyroid hormone concentrations

- Thyroid hormone concentrations are poor indicators of iodine status(adults)
- In iodine-deficient populations, serum T3 increases or remains unchanged, and serum T4 usually decreases
- The changes are often within the normal range, and the overlap with iodine-sufficient populations is large enough to make thyroid hormone levels an insensitive measure of iodine nutrition
- TSH is a sensitive indicator of iodine status in the newborn period

- Assessment of the iodine deficiency disorders and monitoring their elimination. Geneva: World Health Organization, 2007.
- Zimmermann MB,etal. Am J Clin Nutr 2005

The spectrum of **IDD**

Fetus	• Abortions • Stillbirths • Congenital anomalies • Increased perinatal mortality • Neurologic creatinism • Psychomotor defects
Neonate	• Neonatal goiter • Neonatal hypothyroidism
Child & adolescent	• Goitrous juvenile hypothyroidism • Impaired mental function • Retarded physical development
Adult	• Goiter with its complications • Hypothyroidism • Impaired mental function

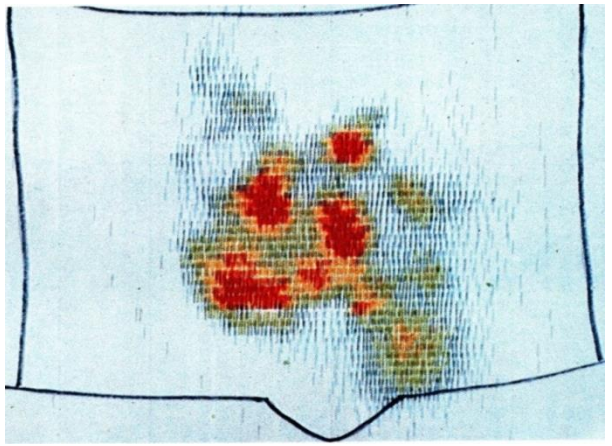
Assessment of the iodine deficiency disorders and monitoring their elimination. Geneva: World Health Organization, 2007

Endemic Goiter

- More than 5% of the pre-adolescent (6-12 years) school age children have enlarged thyroid glands

Simple (nontoxic goiter)

Three women of the Himalayas with typical endemic goiters.



Huge Multinodular goiter

Zimmermann MB,etal. Am J Clin Nutr 2005

Iodine deficiency in the fetus

- Mental retardation:
  - ✓Is the result of iodine deficiency in the mother
  - ✓Insufficient supply of TH to the developing brain may result in mental retardation

Zimmermann MB,etal. Am J Clin Nutr 2005

Endemic Cretinism

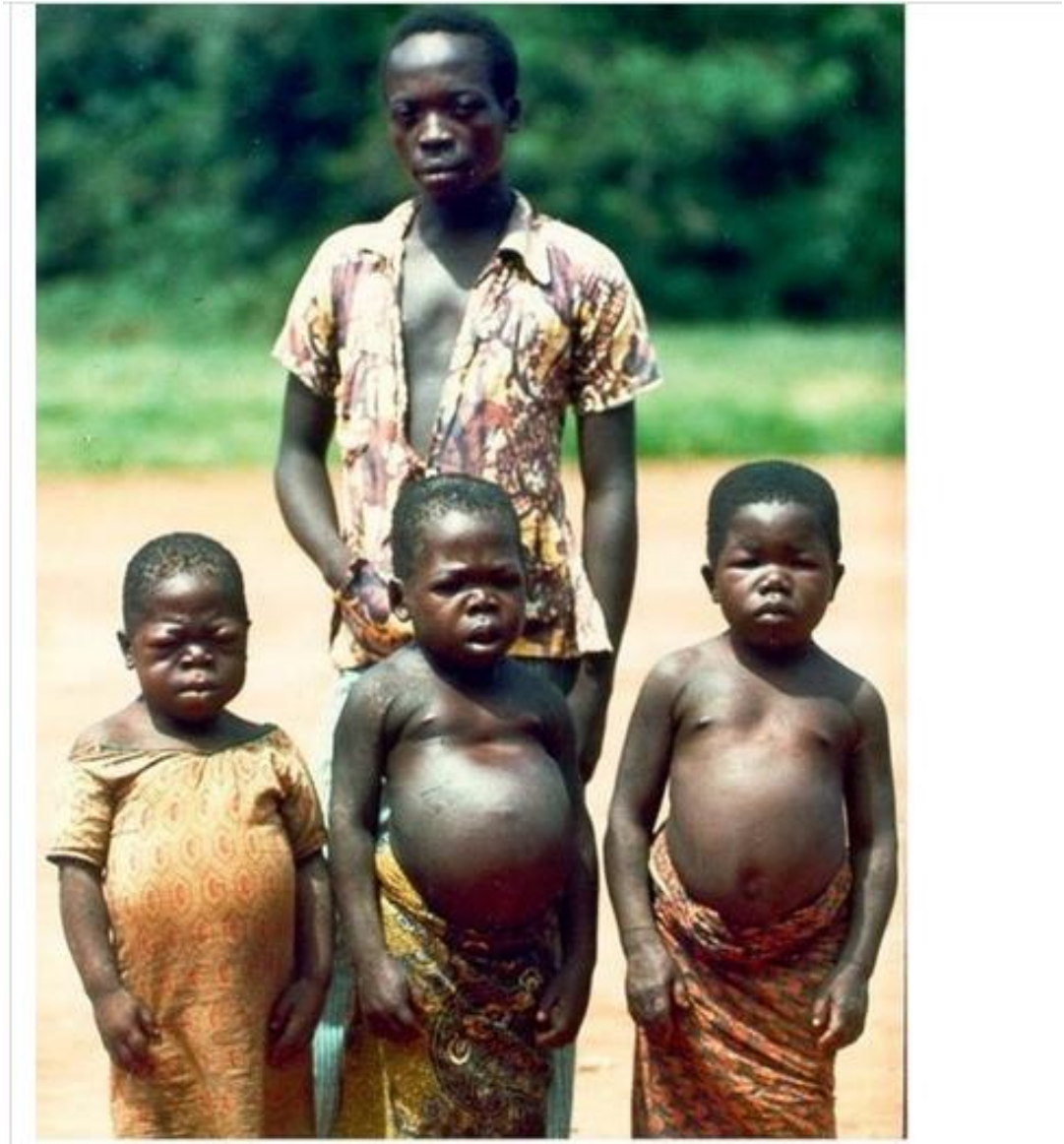
- Neurologic form
  - ✓Deafness (Cochlear lesion)
  - ✓Motor spasticity (spastic diplegia)
  - ✓ Proximal rigidity of both lower and upper extremities and the trunk
  - ✓Goiter
- Myxedematous form
  - ✓Less sever degree of mental retardation
  - ✓Sever growth retardation
  - ✓Puffy features
  - ✓Myxedematous and dry skin
  - ✓Delayed sexual maturation
  - ✓No goiter

Zimmermann MB,etal. Am J Clin Nutr 2005

Endemic cretinism
A 40 years old man, deaf-mute, unable to stand or walk

Zimmermann MB,etal. Am J Clin Nutr 2005

Myxedematous endemic cretinism in the Democratic Republic of Congo. Four inhabitants aged 15-20 years : a normal male and three females with severe longstanding hypothyroidism with dwarfism, retarded sexual development, puffy features, dry skin and hair and severe mental retardation.



Iodine Deficiency in the Child

REGIONS	TESTS	FINDINGS	AUTHORS
Spain	Locally adpated BAYLEY McCARTHY CATTELL	Lower psychomotor and mental development than controls	Bleichrodt et al. 1989
Italy			
Sicily	BENDER- GESTALT	Low preceptual integrative motor ability Neuromuscular and neurosensorial abnormalities	Vermiglio et al. 1990
Tuscany	WECHSLER RAVEN	Low verbal IQ, perception, motor and attentive functions	Fenzi et al. 1990
Tuscany	WISC Reaction time	Lower velocity of motor response to visual stimuli	Vitti et al. 1992 Aghini-Lombardi et al. 1995
India	Verbal, pictorial learning tests Tests of motivation	Lower capacities learning	Tiwari et al. 1996
Iran	Bender-Gestalt Raven	Retardation in psychomotor development	Azizi et al. 1993
Malawi	Psychometric tests including verbal fluency	Loss of 10 IQ points as compared to iodine-supplemented controls	Shrestha 1994
Benin	Battery of 8 non verbal tests exploring fluid intelligence and 2 psychomotor tests	Loss of 5 IQ points as compared to controls supplemented with iodine for one year	van den Briel et al. 2000

Zimmermann MB,etal. Am J Clin Nutr 2005

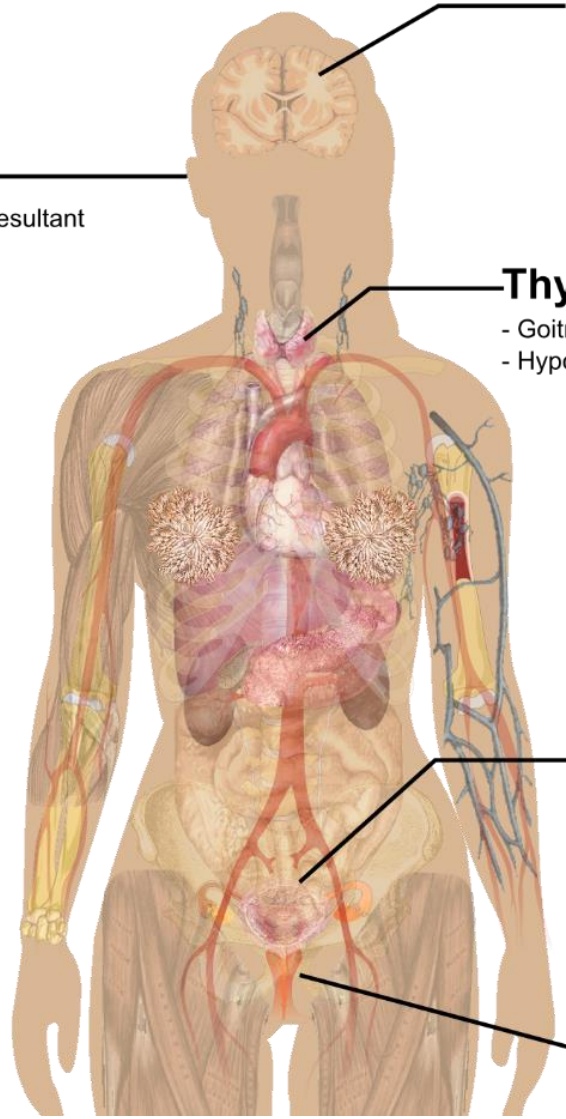
Iodine deficiency in the adult

- Severe iodine deficiency causes goiter and hypothyroidism
- Mild-to-moderate iodine deficiency, increased thyroid activity can compensate for low iodine intake and maintain euthyroidism in most
- Chronic thyroid stimulation results in an increase in the prevalence of toxic nodular goiter and hyperthyroidism in population

Zimmermann MB,etal. Am J Clin Nutr 2005

Symptoms of

Iodine deficiency



Brain
- Mental retardation
- Speech disorders
- Spastic diplegia

Ears
- Deafness and resultant mutism

Thyroid gland
- Goitre
- Hypothyroidism

Constitutional
- Short stature

Pregnancy
- Increased risk of miscarriage stillbirth, congenital defects (e.g., deaf mutism) and perinatal mortality.

Reproductive
- Infertility

Indicators of IDD status

- Clinical indicators
  - ✓Goiter size (palpation, US)
  - ✓ Cretinism
- Biochemical indicators
  - ✓ Urinary iodine level
  - ✓ Blood constituents (TSH, Tg)

Conclusion

- IDDs are the most important cause of preventable mental retardation worldwide
- The consequence can be seen a fetus, a child and adults
- Indicators of iodine status are chemical and biochemical indi