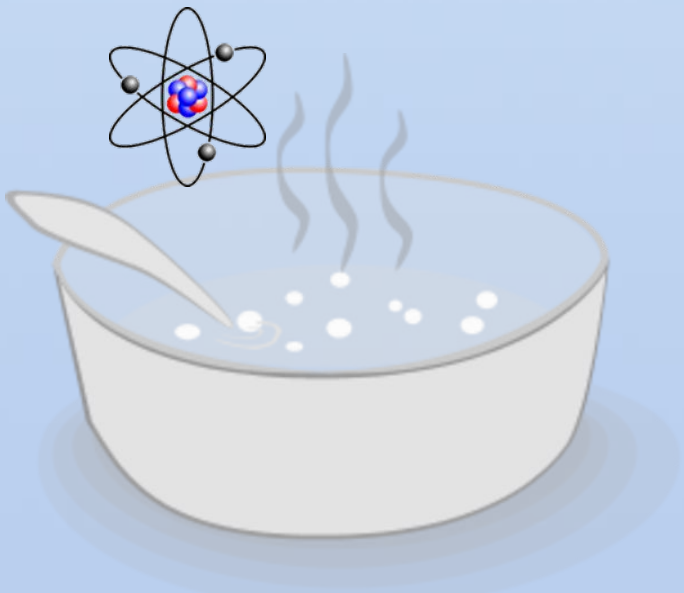
IAEA
International Atomic Energy Agency

The IAEA's contribution to improved nutrition and health

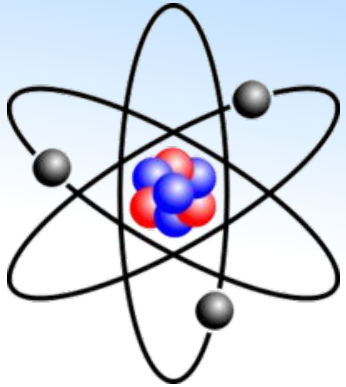
The use of nuclear techniques to assess body composition and breastfeeding practices



Cornelia Loechl, PhD

Section Head, Nutritional and Health-Related Environmental Studies

What to expect?



- What is the IAEA?
- What is IAEA‘s role in nutrition programmes?
- What are isotopes?
- Examples of the use of stable isotope techniques for assessment of body composition/breastfeeding
- Which services does the IAEA provide in nutrition?

International Atomic Energy Agency

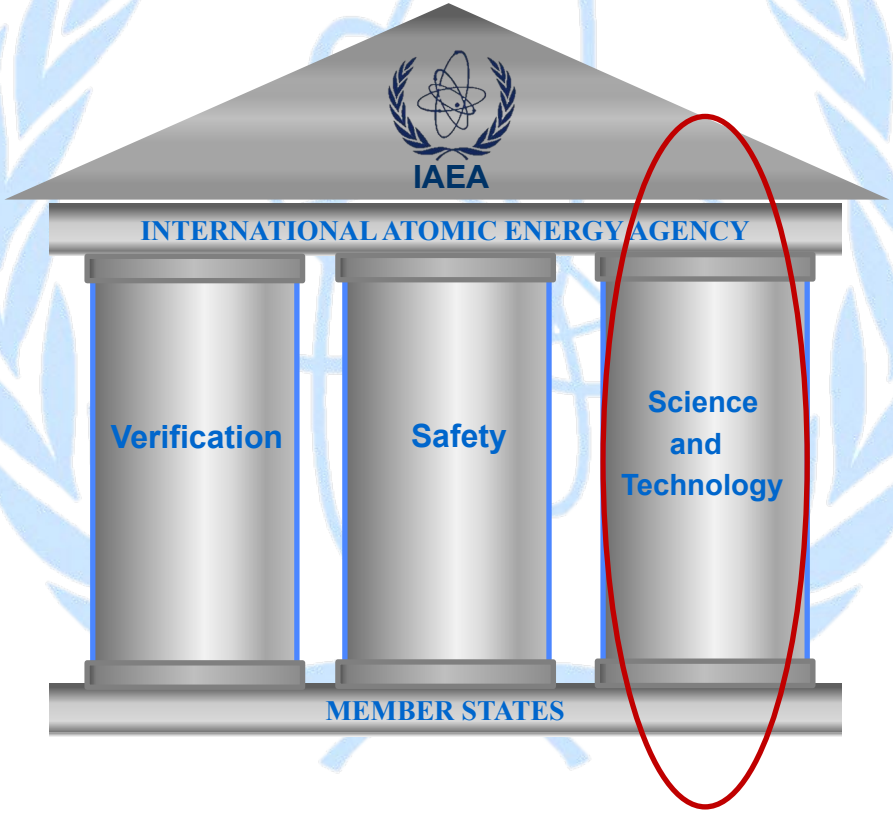
- IAEA is an specialized technical agency of the United Nations System;
- Established in 1957 as the world's "Atoms for Peace" organization;
- Works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies;
- Headquarters in Vienna with offices in Geneva, Tokyo, Toronto, and New York.

IAEA Mandate

“Atoms for Peace and Development”

To seek to accelerate and enlarge the contribution of nuclear techniques to peace, **health and prosperity** throughout the world.

The Three "Pillars" of the IAEA



Department of Nuclear Sciences & Applications

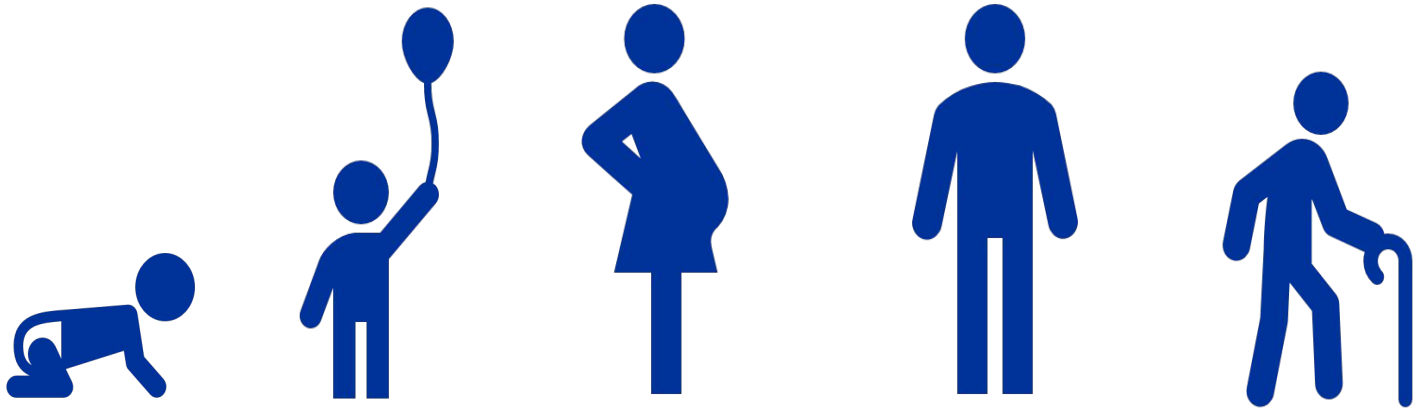
- Human Health
- Environment
- Food and Agriculture (Joint Division with FAO)
- Water Resources
- Radioisotope Production and Radiation Technology
- Nuclear Science



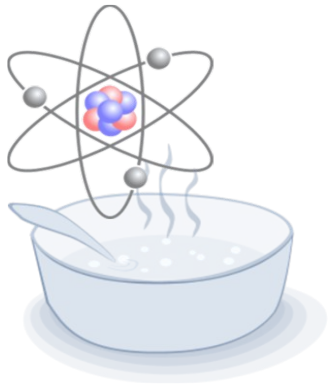


Nutrition for Improved Human Health

Using stable isotopes to combat malnutrition throughout life



- Early Life Nutrition
- Prevention and Management of NCDs
- Diet Quality and Nutrition Security



Proven nutrition interventions to which the IAEA can contribute to

Stable isotope techniques can be used **to monitor and evaluate programmes** designed to:

- Promote good nutritional practices, including breastfeeding and appropriate healthy foods for infants
- Increase the intake of vitamins and mineral through food fortification and supplements
- Prevent and treat moderate and severe malnutrition

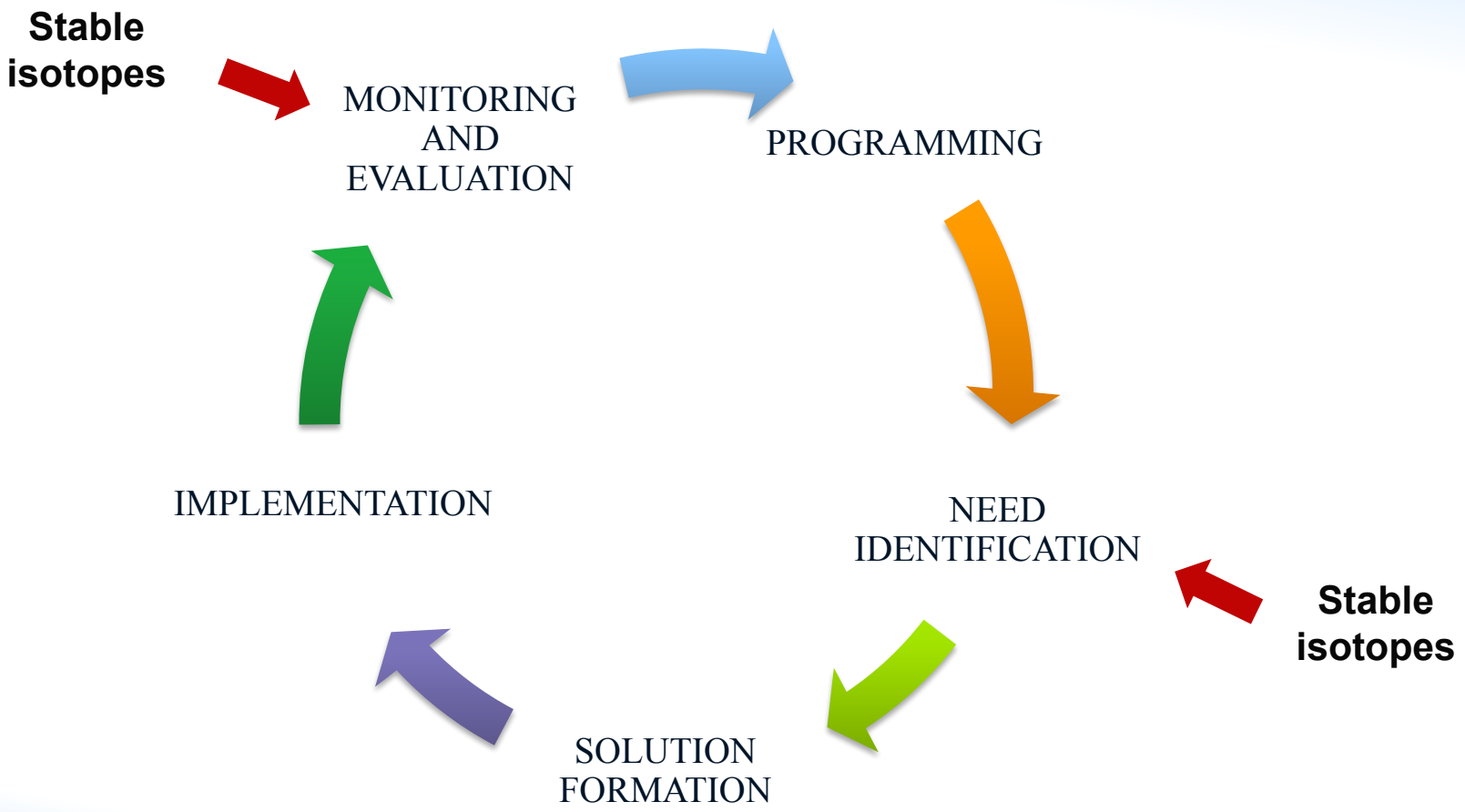
What is needed to improve the nutrition situation?

- Implementation of evidence-based interventions for improvement of maternal and child nutrition
- Need better tools for programme evaluation
- Need for capacity building to tackle malnutrition

Where comes IAEA in?

- Better tools
- Capacity building

Where does IAEA come in?

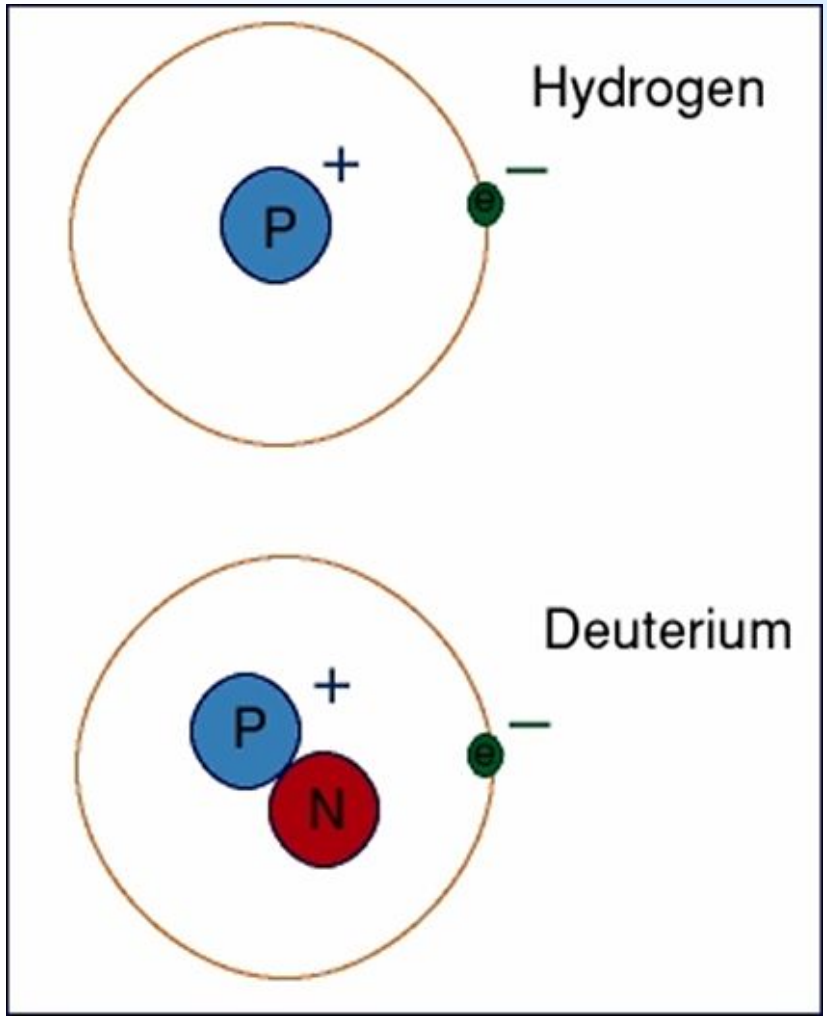


What are Isotopes?

- Isotopes of an element have the same number of protons in the nucleus (atomic number)

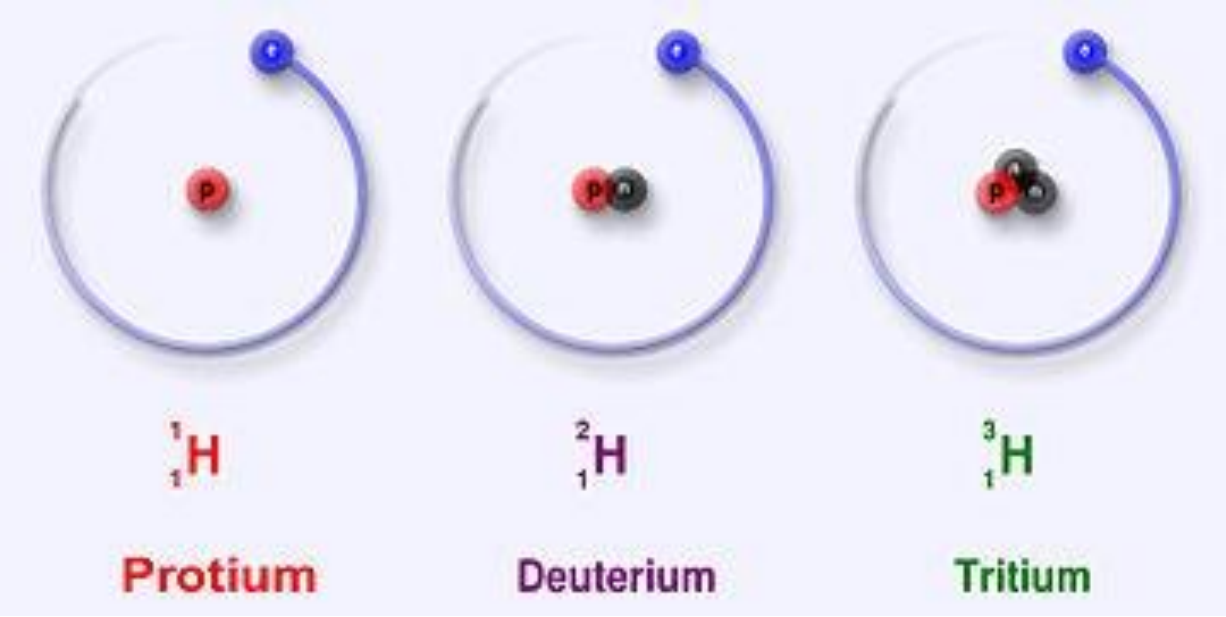
but

- Different atomic mass (the sum of number of protons + number of neutrons)



Isotopes of Hydrogen

Hydrogen has 3 isotopes:



^{1}H	^{2}H	^{3}H
1.00794 99.985%	2.0141 0.015%	$t_{1/2}$ =12.32yrs
Stable	Stable	Cosmogenic/ anthropogenic

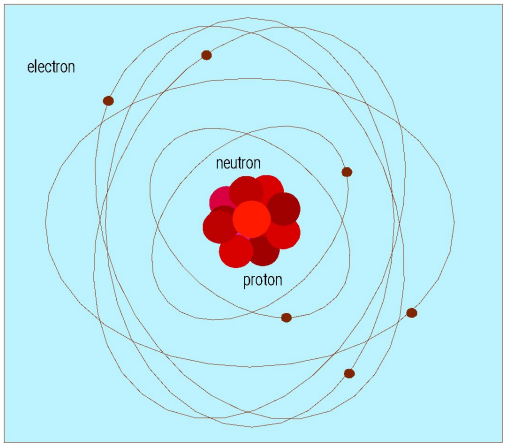
Stable isotopes of interest in nutrition

	Major stable isotope	Minor stable isotope
Hydrogen	^{1}H	^{2}H
Carbon	^{12}C	^{13}C
Oxygen	^{16}O	^{18}O

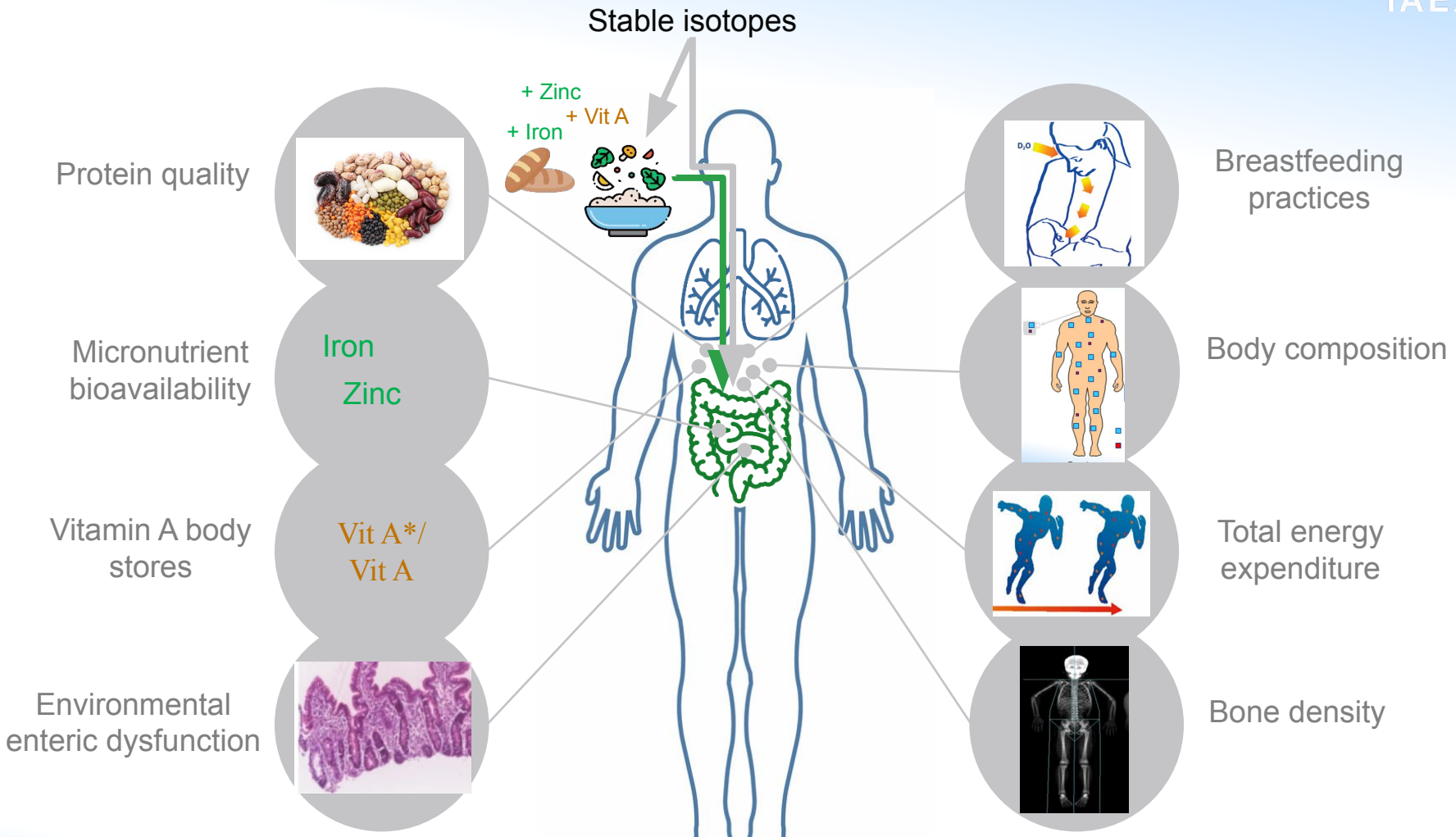
Stable isotopes are also available for elements such as **nitrogen, calcium, iron and zinc**. Compounds such as **vitamin A** can be labelled with the stable isotopes of hydrogen or carbon.

Summary on stable isotopes

- Unlike radioisotopes which are unstable, stable isotopes are safe and emit no radiation
- Stable isotopes occur naturally in our environment and our organism (natural abundance)
- Use stable isotopes that are less present in nature
- Need to collect baseline sample
- Suitable for all ages (pregnant women, lactating mothers, children)
- Can be used in community settings



IAEA's Support of Nuclear Applications in Nutrition



Support Mechanisms of IAEA

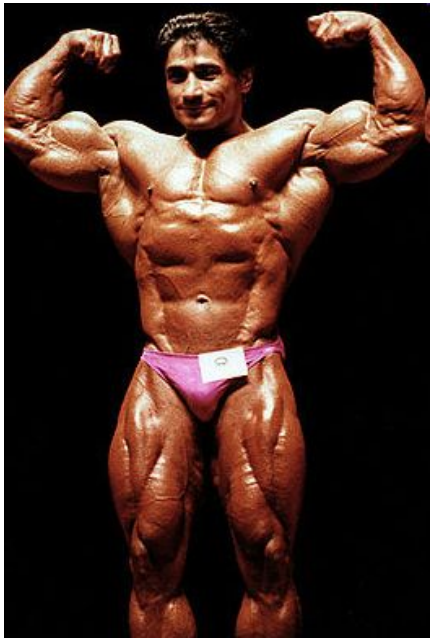
Coordinated Research Projects

- Call for research proposals
- Respond to research questions
- Small group of research institutes
- 4-5 year cycles
- Small annual grants
- Regular coordination meetings

Technical Cooperation Programme

- Concept submission from Member States
- Building and strengthening capacity to use stable isotope techniques
- Biannual planning cycle
- Training, expert advice, equipment, sample analysis, data management/analysis

Same height or same weight does not mean same body composition



The Lancet, 363, 157–163

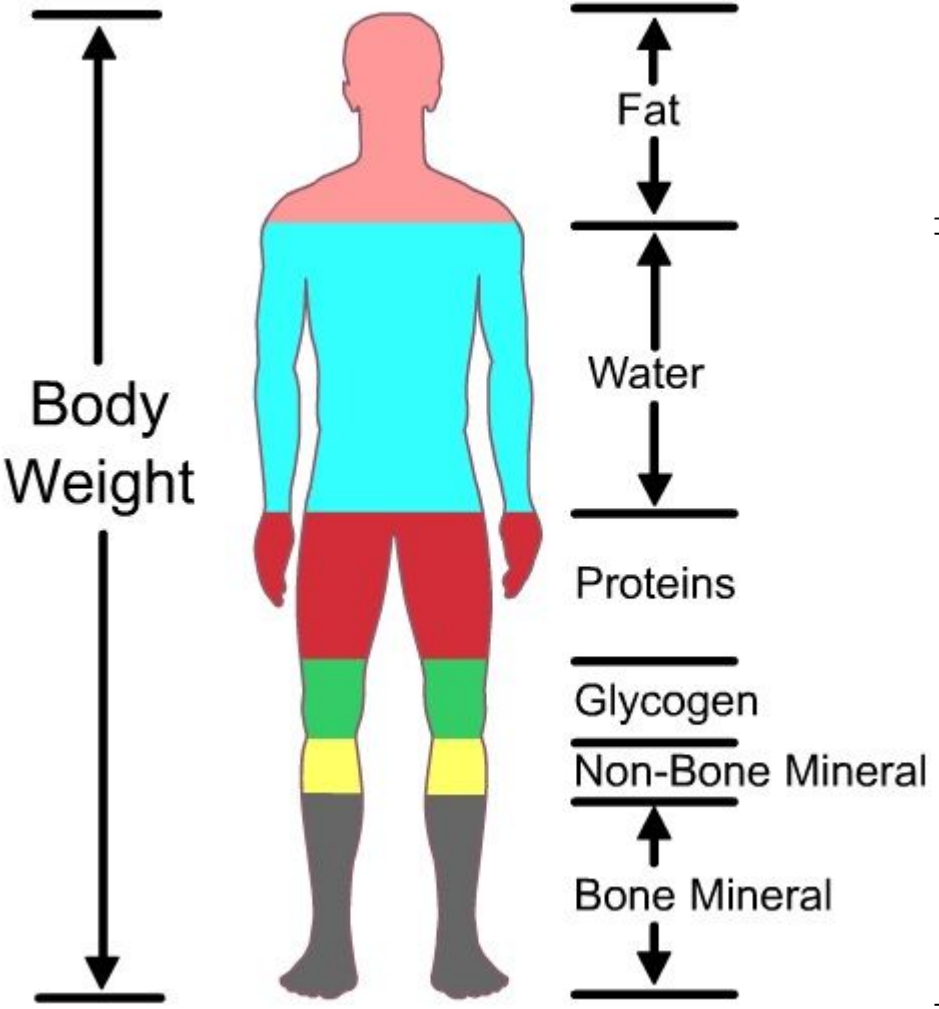
BMI = 35

More muscle

BMI=29

More fat

Body composition



Fat

Fat free mass

How to assess body composition by deuterium dilution

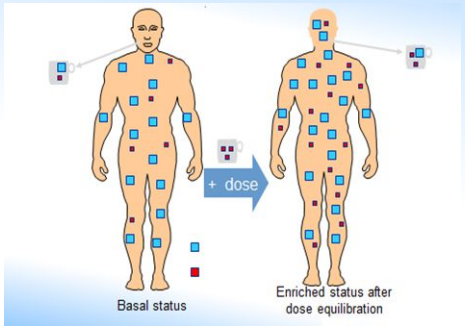
1. Baseline sample

2. Deuterium oxide

3. Collect 1 post dose sample

3-4 hours after dosing

Equilibration 3 – 4 hours



4. Measure abundance

5. Calculate TBW → FFM

Hydration factors!!

6. FM = Body weight − FFM

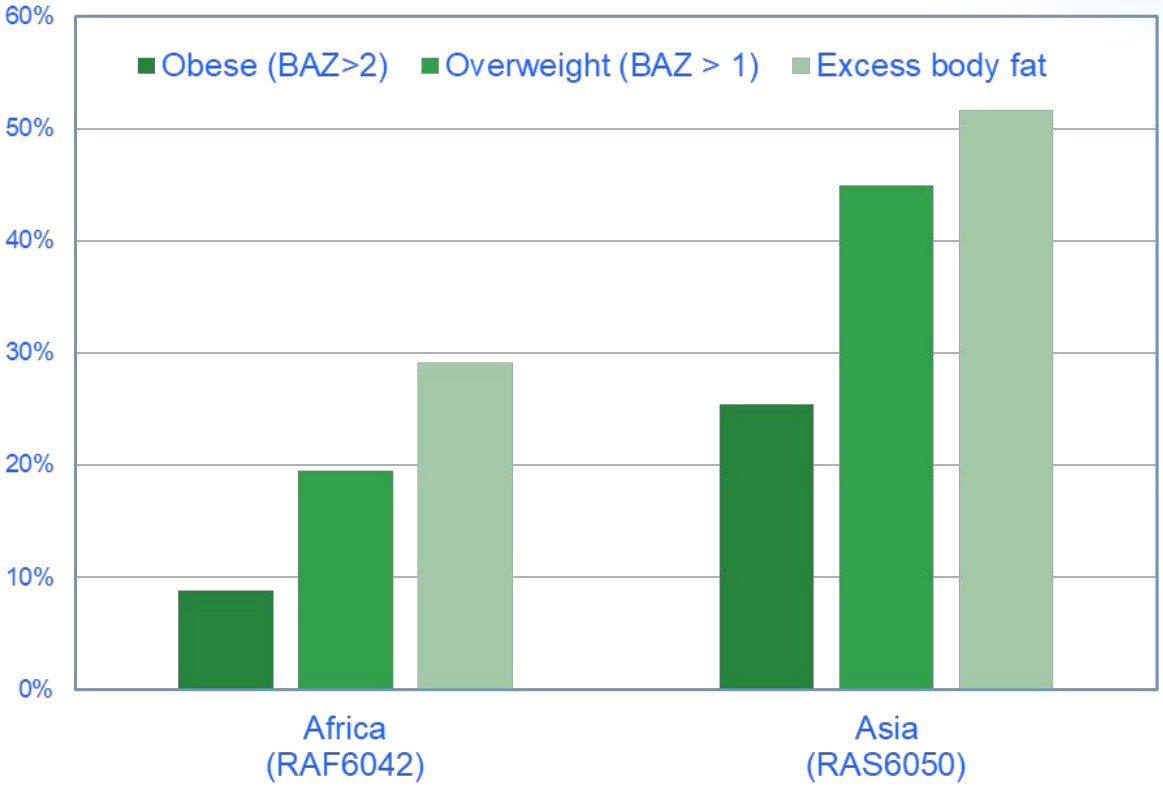
Applying Body Composition Data

- Natural changes as individuals grow
- Generate new data on childhood obesity
- Long term effects of acute malnutrition
- Effect of interventions to treat acute malnutrition or prevent obesity

Obesity, overweight and excess body fat in children

More fat than we think?

Do we measure the right thing?



Excess body fat defined as

>30% in girls

>25% in boys

Applying Nuclear Techniques to Understand the Link between Early Life Nutrition and Later Childhood Health – research project

- To investigate the relationship between the first 1000 days and later childhood body composition
- To explore whether interventions during the first 1000 days can influence childhood body composition and associated NCD risk factors

Cohort A – mother received intervention from preconception and child from birth

Preconception	Pregnancy	Infancy	Childhood

Cohort B – mother received intervention in pregnancy

	Pregnancy	Infancy	Childhood

Cohort C – Child received previous intervention in infancy

		Infancy	Childhood

Cohort D – No intervention received

Preconception	Pregnancy	Infancy	Childhood

Fat-free mass at birth positively associated with brain development in first 5 years of life

Original Article | Published: 27 September 2017

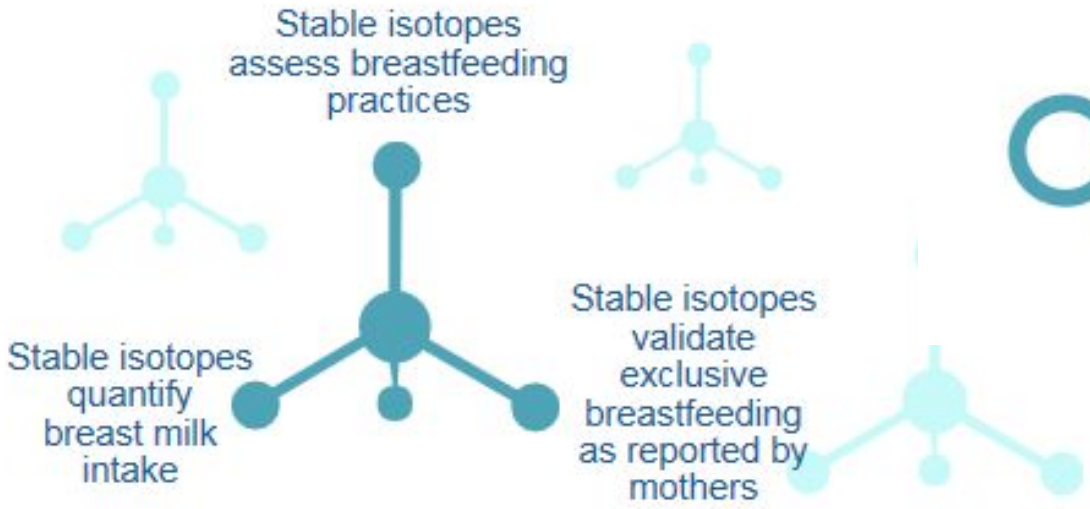
Body composition, energy expenditure and physical activity

Relation between body composition at birth and child development at 2 years of age: a prospective cohort study among Ethiopian children

M Abera, M Tesfaye, T Girma, C Hanlon, G S Andersen, J C Wells, B Admassu, R Wibaek, H Friis & P Kæstel

Data courtesy: Mubarek et al. iABC Cohort, Jimma University, Ethiopia

IAEA's Role in Breastfeeding Promotion

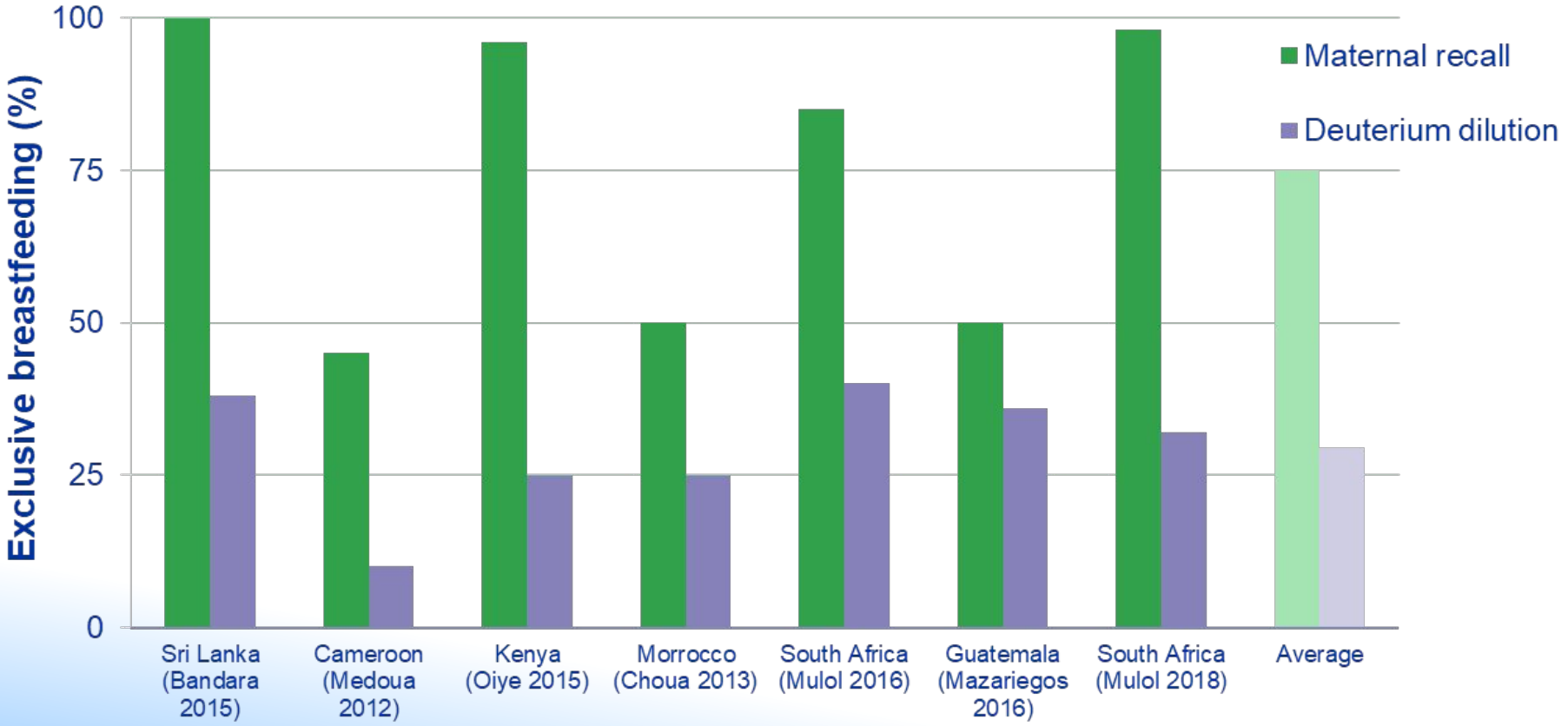


IAEA assesses interventions to promote optimal breastfeeding practices and monitors progress of achieving the targets.

WHA targets 2025

Increase the rate of exclusive breastfeeding in the first 6 months up to at least 50%.

Assessment of interventions aimed at promoting exclusive breastfeeding



Exclusive Breastfeeding & Body Composition at 12 months

Maternal & Child Nutrition

DOI: 10.1111/mcn.12338

Original Article

Association of 6 months of exclusive breastfeeding with higher fat-free mass in infants in a low-resource setting with high HIV prevalence in South Africa

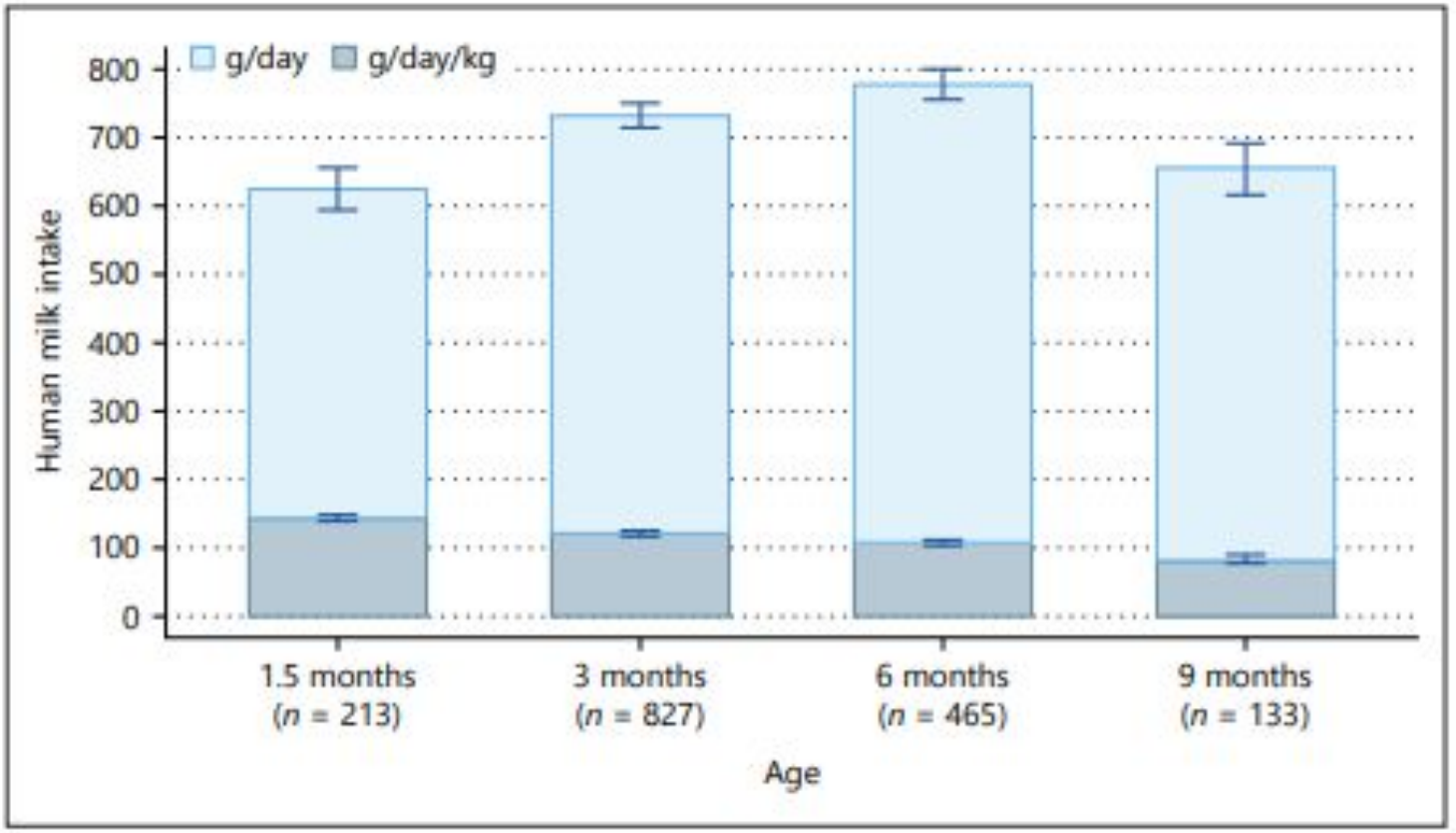
Helen Mulol and Anna Coutsoudis

Department of Paediatrics and Child Health, University of KwaZulu-Natal, Durban, South Africa

Matern Child Nutr. 2017 Apr;13(2).

Results showed that infants who were exclusively breastfed for 6 months had a higher per cent fat-free mass at 12 months compared with infants who were not exclusively breastfed for 6 months ($P<0.05$).

Assessment of amounts of breast milk consumed in the first year of life



Breast milk intake over time in g/day and g/kg body weight per day
(Source: IAEA supported projects)

Deuterium dose-to-mother techniqu
how does it work?

1. Mother consumes a single oral dose of deuterated water
2. Deuterium mixes with mother's body water
3. Infant consumes deuterium through mother's milk
4. Saliva is sampled from the mother and infant for 2 weeks
5. Amount of deuterium is analysed
6. Amount of breast milk consumed and amount of water from sources other than breast milk is calculated

Services to Member States

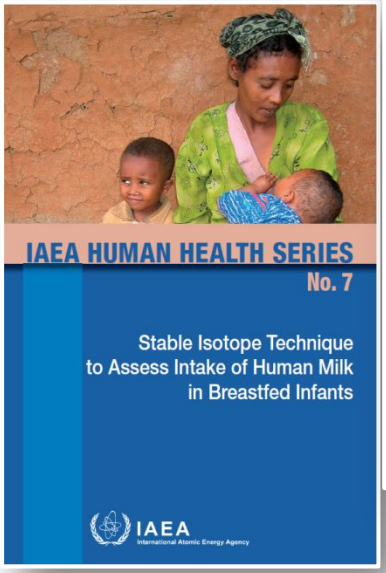
Guidance Documents

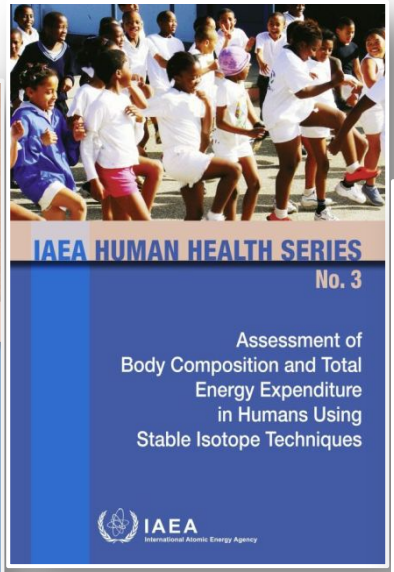
Education

Databases

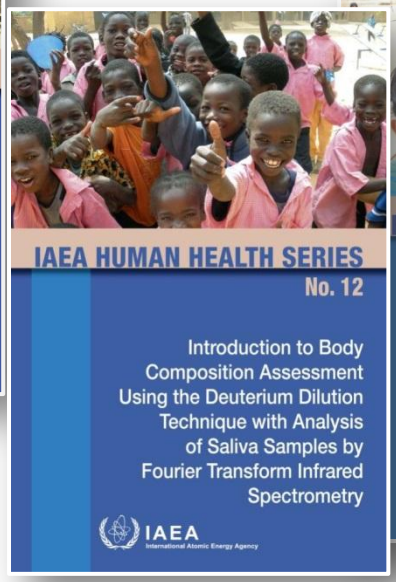
Inter-laboratory Studies

Guidance documents





Also available in Spanish and French!



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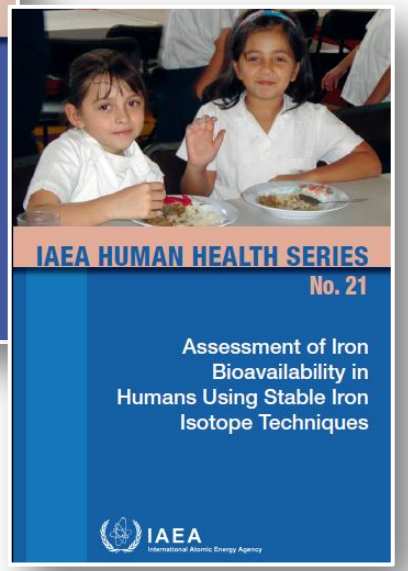
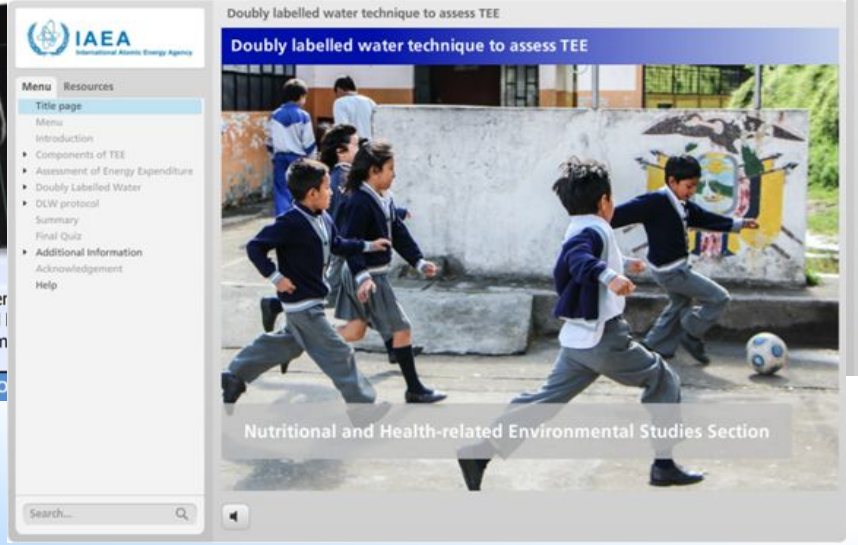
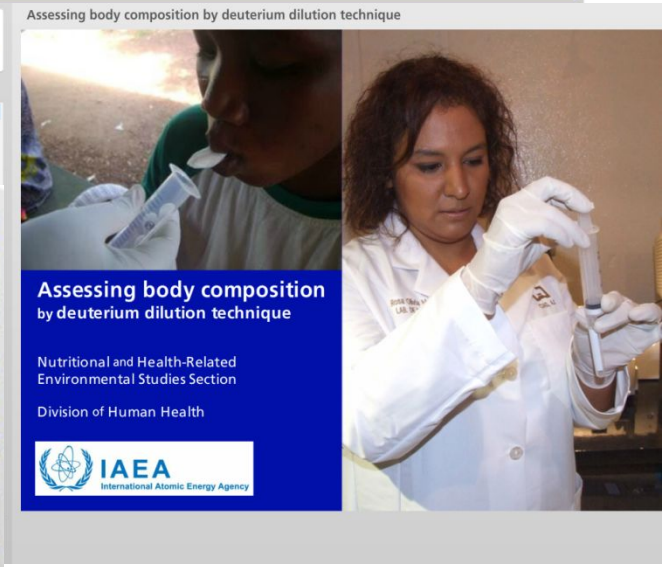


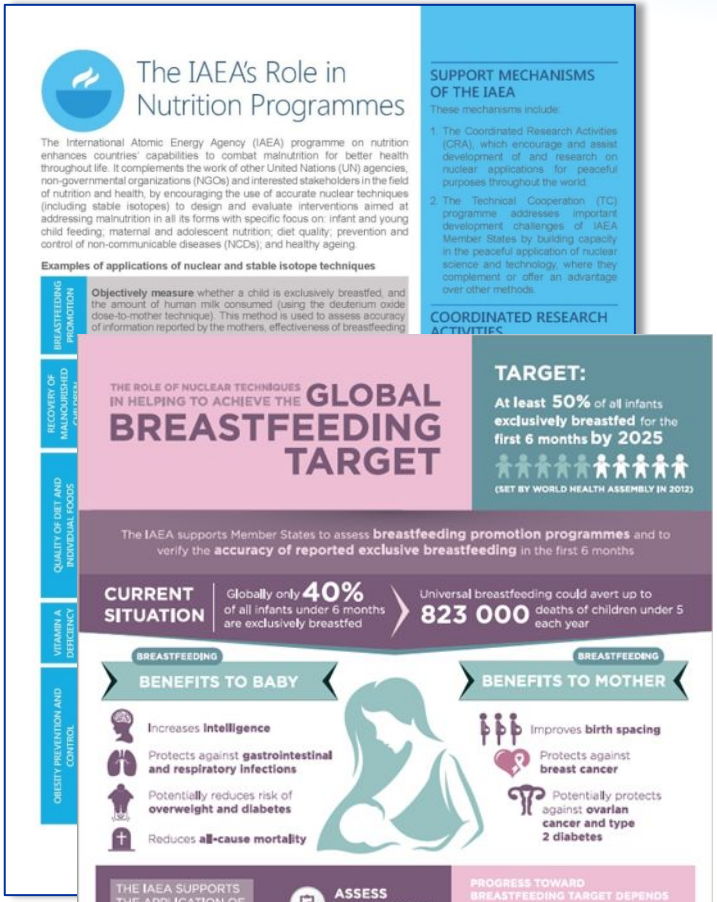
Available on: https://nucleus.iaea.org/HHW/Nutrition/

IAEA e-learning Modules





Outreach material



The IAEA's Role in Nutrition Programmes

The International Atomic Energy Agency (IAEA) programme on nutrition enhances countries' capabilities to combat malnutrition for better health throughout life. It complements the work of other United Nations (UN) agencies, non-governmental organizations (NGOs) and interested stakeholders in the field of nutrition and health, by encouraging the use of accurate nuclear techniques (including stable isotopes) to design and evaluate interventions aimed at addressing malnutrition in all its forms with specific focus on: infant and young child feeding; maternal and adolescent nutrition; diet quality; prevention and control of non-communicable diseases (NCDs); and healthy ageing.

Examples of applications of nuclear and stable isotope techniques

BREASTFEEDING PROMOTION

Objectively measure whether a child is exclusively breastfed, and the amount of human milk consumed (using the deuterium oxide dose-to-mother technique). This method is used to assess accuracy of information reported by the mothers, effectiveness of breastfeeding

RECOVERY OF MALNOURISHED CHILDREN

QUALITY OF DIET AND INDIVIDUAL FOODS

VITAMIN A DEFICIENCY

OBESITY PREVENTION AND CONTROL

SUPPORT MECHANISMS OF THE IAEA

These mechanisms include:

1. The Coordinated Research Activities (CRA), which encourage and assist development of and research on nuclear applications for peaceful purposes throughout the world.
2. The Technical Cooperation (TC) programme addresses important development challenges of IAEA Member States by building capacity in the peaceful application of nuclear science and technology, where they complement or offer an advantage over other methods.

COORDINATED RESEARCH ACTIVITIES

THE ROLE OF NUCLEAR TECHNIQUES IN HELPING TO ACHIEVE THE

GLOBAL BREASTFEEDING TARGET

TARGET:

At least 50% of all infants **exclusively breastfed** for the **first 6 months by 2025**

(SET BY WORLD HEALTH ASSEMBLY IN 2012)

The IAEA supports Member States to assess **breastfeeding promotion programmes** and to verify the **accuracy of reported exclusive breastfeeding** in the first 6 months

CURRENT SITUATION | Globally only **40%** of all infants under 6 months are exclusively breastfed | Universal breastfeeding could avert up to **823 000** deaths of children under 5 each year

BREASTFEEDING

BENEFITS TO BABY

- Increases **intelligence**
- Protects against **gastrointestinal and respiratory infections**
- Potentially reduces risk of **overweight and diabetes**
- Reduces **all-cause mortality**

BREASTFEEDING

BENEFITS TO MOTHER

- Improves **birth spacing**
- Protects against **breast cancer**
- Potentially protects against **ovarian cancer and type 2 diabetes**

THE IAEA SUPPORTS THE APPLICATION OF STABLE ISOTOPES

STABLE ISOTOPES...

- **ASSESS** breastfeeding practices
- **QUANTIFY** breast milk intake
- **VERIFY** reported exclusive breastfeeding

PROGRESS TOWARD BREASTFEEDING TARGET DEPENDS ON MEASUREMENT METHOD

Exclusive breastfeeding **rates are lower** when the objective isotope method is used compared to mother's recall

The IAEA contributes **evidence** on breastfeeding practices **to monitor the progress** of achieving global breastfeeding targets

IAEA Human Health Programme

60 Years IAEA Atoms for Peace and Development

IAEA **IAEA BRIEF** 2016/3

Human Health

Using Nuclear Techniques to Assess Breastfeeding Practices for Better Nutrition and Health

SUMMARY

1. Appropriate feeding practices in the early months and years of life are important to achieve optimal growth, development and health.
2. Awareness of the important role that breastfeeding plays in preventing malnutrition needs to be increased.

receive nutritionally adequate and safe complementary foods, while continuing to breastfeed for up to two years or beyond.[1]

The benefits of breastfeeding to infants are now well established (see infograph below). It is estimated that universal breastfeeding could avert 823 000 infant deaths each year.[2]

IAEA **IAEA BRIEF** 2018/7

Human Health

Stable Isotope Techniques Help to Address the Double Burden of Malnutrition

SUMMARY

- To be in good health, individuals require nutritious food, high-quality water, physical activity, adequate sleep, and a living environment devoid of germs and toxic contaminants.
- An imbalance in any of these factors may

IAEA **IAEA BRIEF** 2019/3

Human Health

IAEA Support for the Use of Stable Isotope Techniques to Assess Micronutrients

SUMMARY

1. Good nutrition calls for more than just carbohydrates, protein and fat. Humans may eat enough calories to live but still have a diet that fails to provide sufficient levels of crucial vitamins and minerals, also known as micronutrients, which allow them to be physically and mentally healthy.
2. In many low- and middle-income countries (LMICs), diets are largely plant-based. Besides nutrients, plant-based foods contain naturally occurring compounds that limit the absorption of micronutrients.
3. Capacity for assessing the absorption of minerals and vitamin A status is needed to determine diet quality and to design interventions to improve it.
4. The IAEA provides support in using stable isotope techniques to assess the absorption and retention of essential vitamins and minerals, such as vitamin A, iron and zinc.

A child is dosed with vitamin A labelled with a stable isotope. (Photo: A. Dhansay/South Africa)

INTRODUCTION

Micronutrients are a class of nutrients needed by the body in small amounts on a regular basis to ensure good health, growth and development. They are important ingredients in the utilization of the major nutrients (protein, carbohydrates and fat) by the body. Important bodily functions, such as red blood synthesis, enzyme function, bone strength development, immunity and vision, depend on micronutrients. Micronutrients include all vitamins, as well as some minerals, such as zinc, iron, chromium, copper, manganese and iodine.

A lack of essential vitamins and minerals often results in 'hidden hunger', where the signs of undernutrition are less visible and people may not even be aware of it. Hidden hunger has been estimated to affect as many as two billion people globally[1].

Hidden hunger can impair the mental and physical development of children and adolescents and result in lower IQ, stunting and blindness; women and children in LMICs are especially vulnerable.

The IAEA supports countries in using stable isotope techniques to combat micronutrient malnutrition. These techniques can be used to assess diet quality in terms of micronutrient absorption and an individual's micronutrient status.

[1] WORLD HEALTH ORGANIZATION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Guidelines on food fortification with micronutrients (2006) apps.who.int/iris/bitstream/handle/10665/43412/9241594012_eng.pdf

IAEA Office of Public Information and Communication • October 2019

IAEA **IAEA FACTSHEET**

Human Health

How the Retinol Isotope Dilution Test Can Help Assess Vitamin A Status in Public Health Programmes

What should I know?

Vitamin A is an essential nutrient for normal vision, cellular growth and development, proper functioning of the immune system and synthesis of red blood cells. It is mostly stored in the liver. Vitamin A deficiency (VAD) remains a leading cause of childhood blindness and is a major contributor to anaemia and infectious disease morbidity and mortality among pre-school children.

The current global prevalence of VAD among children aged 6–59 months is approximately 29%, with the highest prevalence occurring in sub-Saharan Africa (48%) and South Asia (44%)[1]. Worldwide, more than 150 000 children die each year owing to the effects of VAD[2] [Figure 1].

The IAEA is raising awareness of, and building capacity on, the use of an isotopic technique to help assess vitamin A status from deficiency to excess.

What foods contain vitamin A?

Vitamin A, provided either in the form of provitamin A in plant-based products or preformed vitamin A

IAEA **IAEA FACTSHEET**

Human Health

How an Isotope Technique Helps Determine Protein Quality

What should I know?

Proteins, alongside carbohydrates and fats, are referred to as macronutrients, as they must be consumed in large quantities to permit the human body to sustain its normal functions. Proteins are essential for body structure and growth, for regulating organ and tissue function and for protecting against infection. They are also an integral part of human genetic material. All enzymatic reactions and hormonal processes in the body depend on protein.

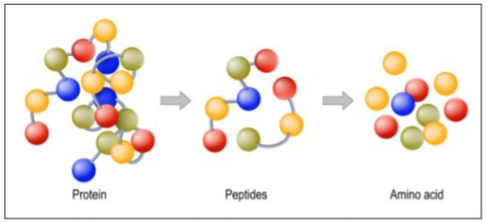
The supply of protein during the first two years of life not only determines growth, but also influences the risk of obesity and non-communicable diseases later in life, as well as the rate of recovery from acute undernutrition.

The IAEA supports Member States in the use of isotope techniques to provide vital data on the quality of protein, which, in turn, can contribute to improving nutritional programmes.

What is the composition of protein?

Proteins are made up of 20 amino acids, which are classified into two categories: non-essential (dispensable) and essential (indispensable).

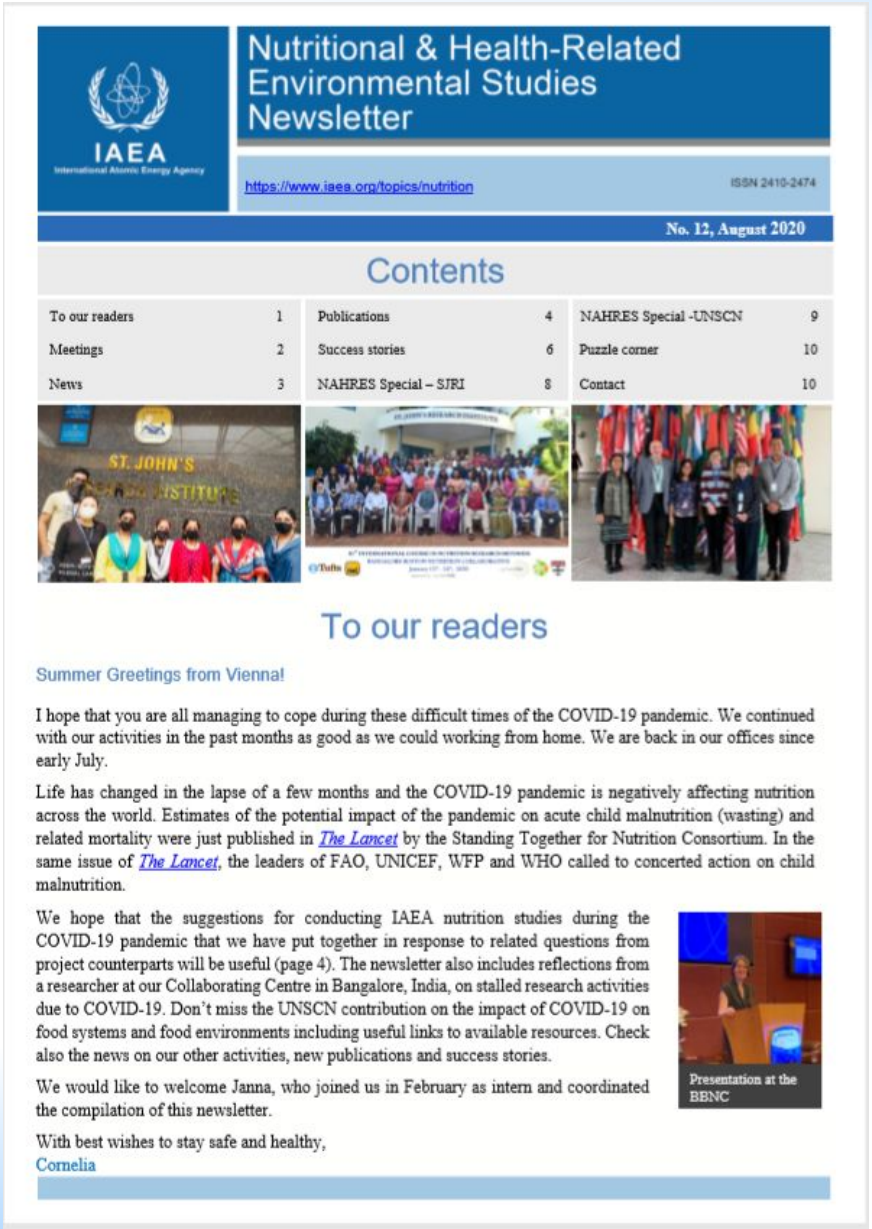
Dispensable amino acids can be synthesized by the body, so they do not necessarily have to be present in the diet. They include alanine, aspartic acid, asparagine, glutamic acid and serine.



A combination of stable isotopes, deuterium and 13-carbon is used to track protein digestion. (Image: 6Stock.com/tttsz)

IAEA Office of Public Information and Communication • March 2020

Newsletter



IAEA
International Atomic Energy Agency

Nutritional & Health-Related Environmental Studies Newsletter

https://www.iaea.org/topics/nutrition

ISSN 2410-2474

No. 12, August 2020

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To our readers

Summer Greetings from Vienna!

I hope that you are all managing to cope during these difficult times of the COVID-19 pandemic. We continued with our activities in the past months as good as we could working from home. We are back in our offices since early July.

Life has changed in the lapse of a few months and the COVID-19 pandemic is negatively affecting nutrition across the world. Estimates of the potential impact of the pandemic on acute child malnutrition (wasting) and related mortality were just published in *The Lancet* by the Standing Together for Nutrition Consortium. In the same issue of *The Lancet*, the leaders of FAO, UNICEF, WFP and WHO called to concerted action on child malnutrition.

We hope that the suggestions for conducting IAEA nutrition studies during the COVID-19 pandemic that we have put together in response to related questions from project counterparts will be useful (page 4). The newsletter also includes reflections from a researcher at our Collaborating Centre in Bangalore, India, on stalled research activities due to COVID-19. Don't miss the UNSCN contribution on the impact of COVID-19 on food systems and food environments including useful links to available resources. Check also the news on our other activities, new publications and success stories.

Presentation at the BBNC

We would like to welcome Janna, who joined us in February as intern and coordinated the compilation of this newsletter.

With best wishes to stay safe and healthy,
Cornelia

Biannual Newsletter

More information: Human Health Campus

IAEA

IAEA | Human Health Campus

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Nutrition

- Body Composition
- Bone Mineral Density
- Total Energy Expenditure
- MAM Symposium 2014
- Human Milk Intake
- Vitamin A Body Pool Size
- Iron and Zinc Bioavailability
- IAEA Nutrition Factsheets, Brochures & Multimedia Material
- Peer-reviewed publications & useful links
- Carbon-13 Breath Tests
- Writing Skills
- Environmental Enteric Dysfunction
- DBMal Symposium 2018

Shortcuts

- Latest
- Events
- Links
- General Public Information
- Databases & Statistics
- IAEA Publications

Nuclear Techniques in Nutrition


Body Composition


Bone Mineral Density


Total Energy Expenditure

MAM Symposium 2014


Human Milk Intake


Vitamin A Body Pool Size


Iron and Zinc Bioavailability

IAEA Nutrition Factsheets, Brochures & Multimedia Material


Peer-reviewed publications & useful links


Carbon-13 Breath Tests


Writing Skills


Environmental Enteric Dysfunction

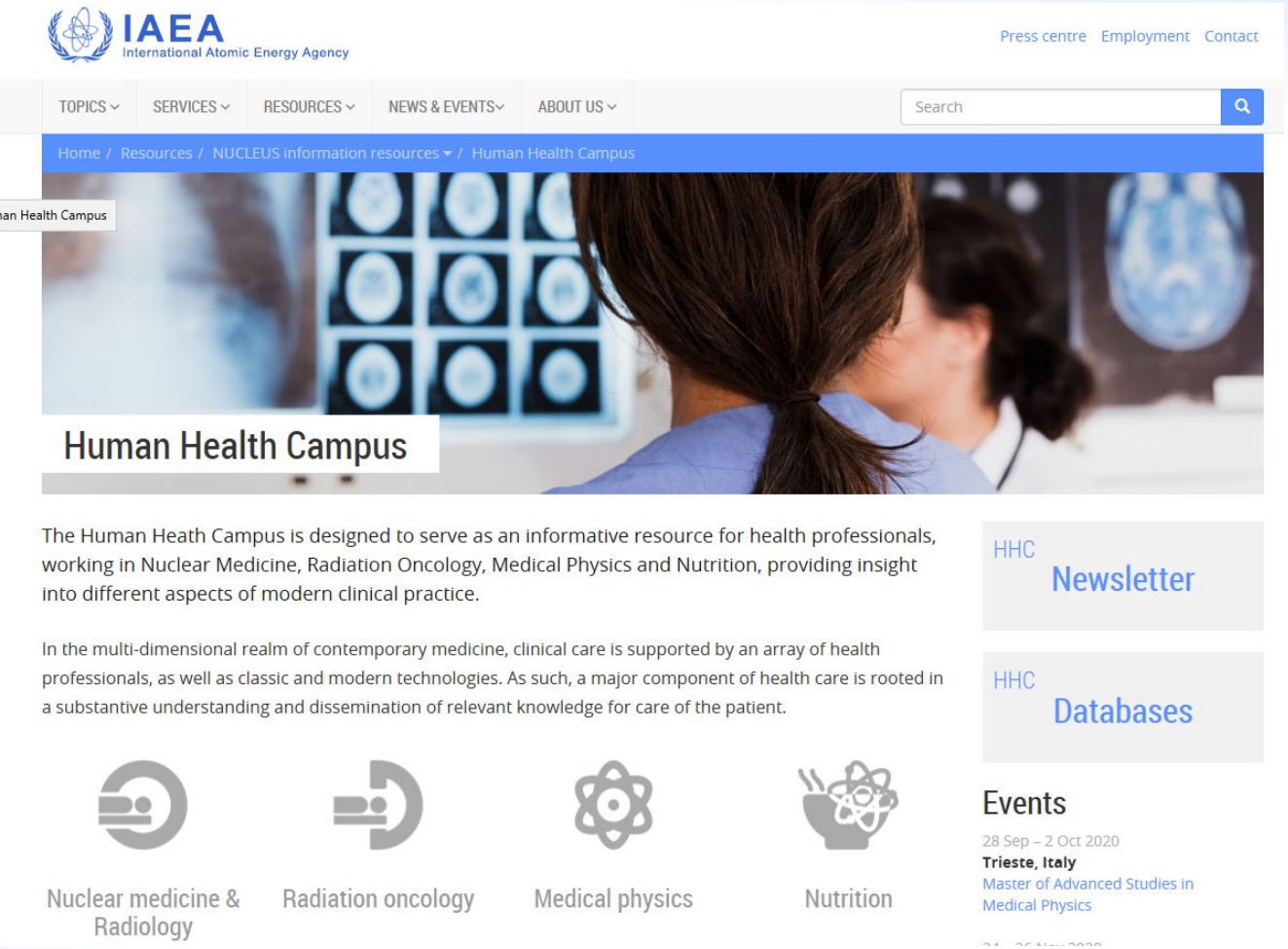

Double Burden of Malnutrition

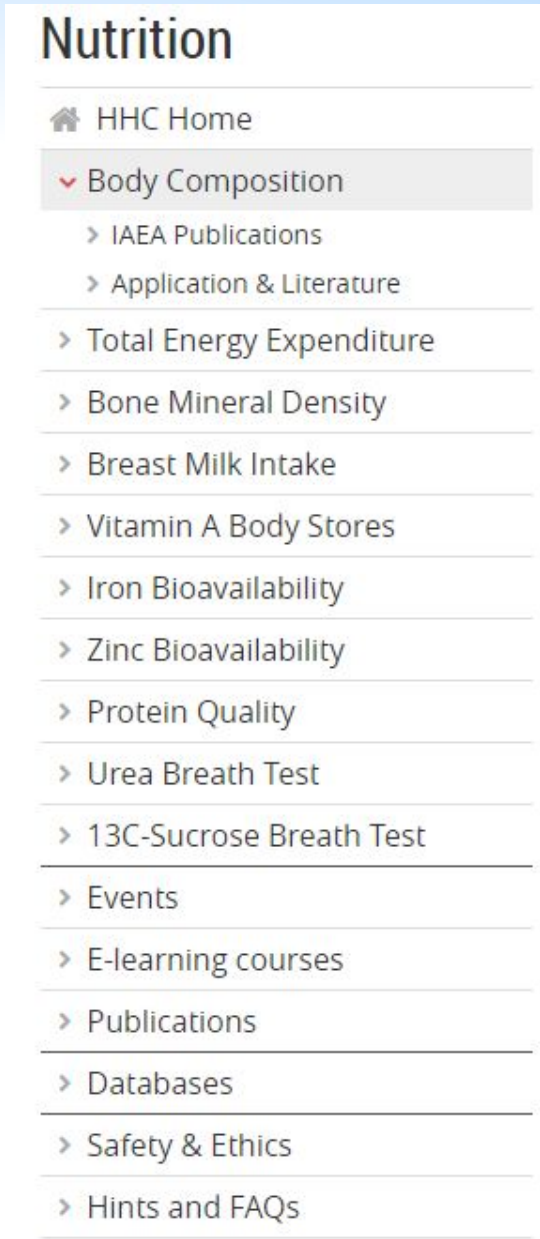

DBMal Symposium 2018

NEW! Use of Stable Isotopes to Evaluate Bioefficacy of Provitamin A Carotenoids, Vitamin A Status, and Bioavailability of Iron and Zinc

https://humanhealth.iaea.org/HHW/Nutrition/index.html

Launching soon





IAEA
International Atomic Energy Agency

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