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Body composition

Assessing body composition using a stable isotope technique to monitor healthy growth and recovery from malnutrition

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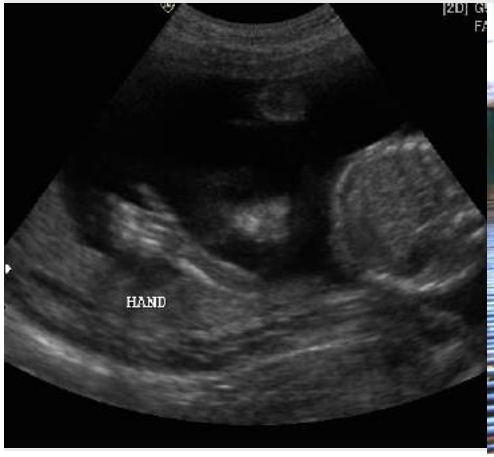
IAEA 'Nutrition for Improved Health'

Enhance Member State capabilities to combat malnutrition in all its forms and to address environment related nutrition issues for better health throughout the life course:

- Maternal, infant and young child nutrition;
- Prevention and control of obesity and non-communicable diseases;
- Health effects of the environment.






IAEA's Contribution to the Global Efforts in Nutrition

The IAEA's work complements the work of other players in nutrition through encouraging the use of stable isotope techniques (safe and non radioactive) in design and evaluation of nutrition interventions

Stable isotope techniques are reference methods for assessment of:

- Body composition;
- Exclusive breastfeeding;
- Total daily energy expenditure;
- Micronutrient absorption;
- Vitamin A status;
- Protein and amino acid bioavailability and metabolism.

Support Mechanisms of IAEA

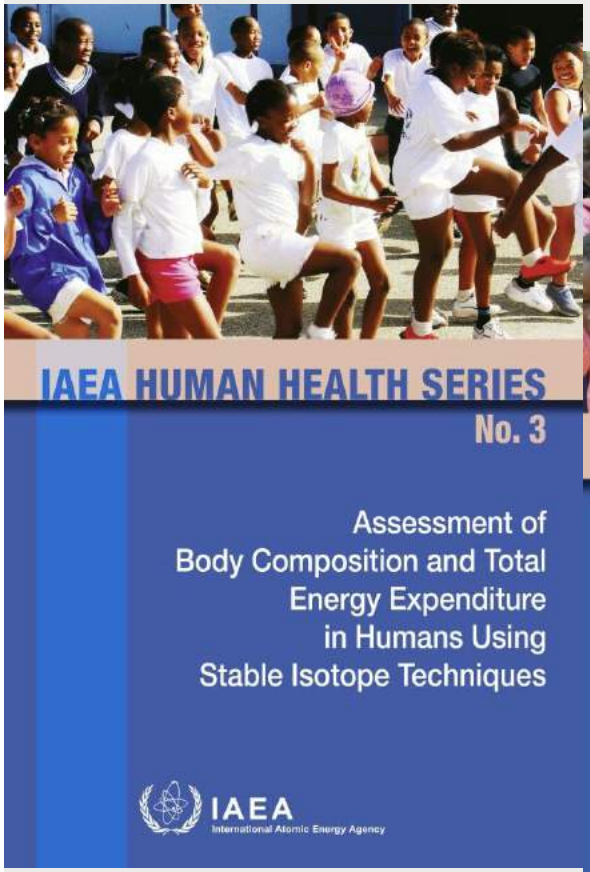
Coordinated Research Projects

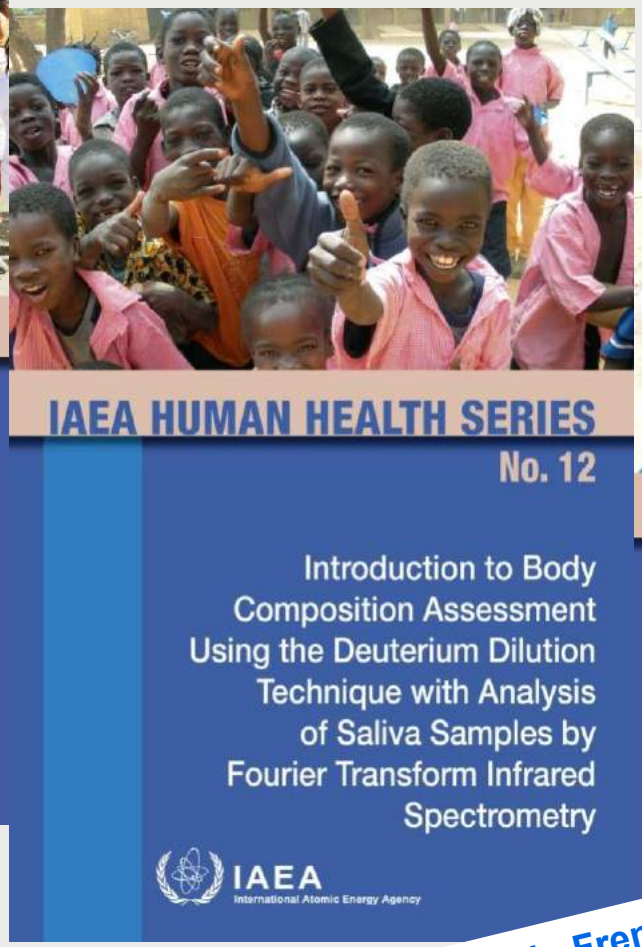
- Call for research proposals
- Respond to research questions
- Small group of research institutes
- 4-5 years
- Small annual grants
- Regular coordination meetings

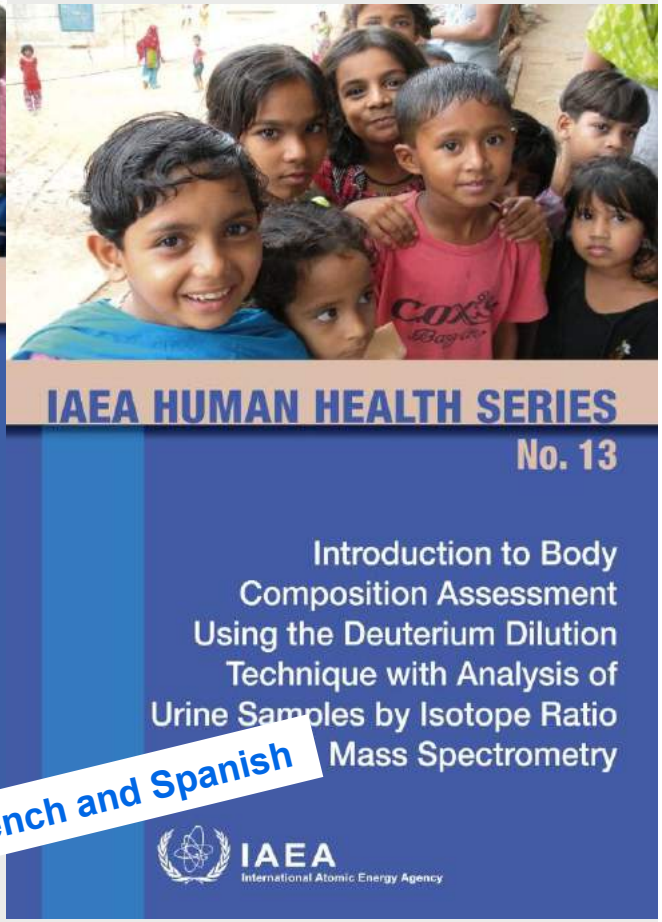
Technical Cooperation Programme

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

IAEA's Human Health Publications







Also available in French and Spanish

http://humanhealth.iaea.org

More information: Human Health Campus

Also on LinkedIn:
IAEA Human Health Campus
Send a request to join the group!

Check out:

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

Implications of body composition

Undernutrition

- The effect of feeding lipid nutrient supplements (LNS) or ready-to-use therapeutic food on body fat accretion

Overnutrition

- Fatness and adiposity – overweight/obesity/diabetes
- Obesity may be programmed by events early in life

Healthy growth – quality of growth

- Association between greater weight gain (rate of weight gain) in early infancy and later fat mass and central fat distribution

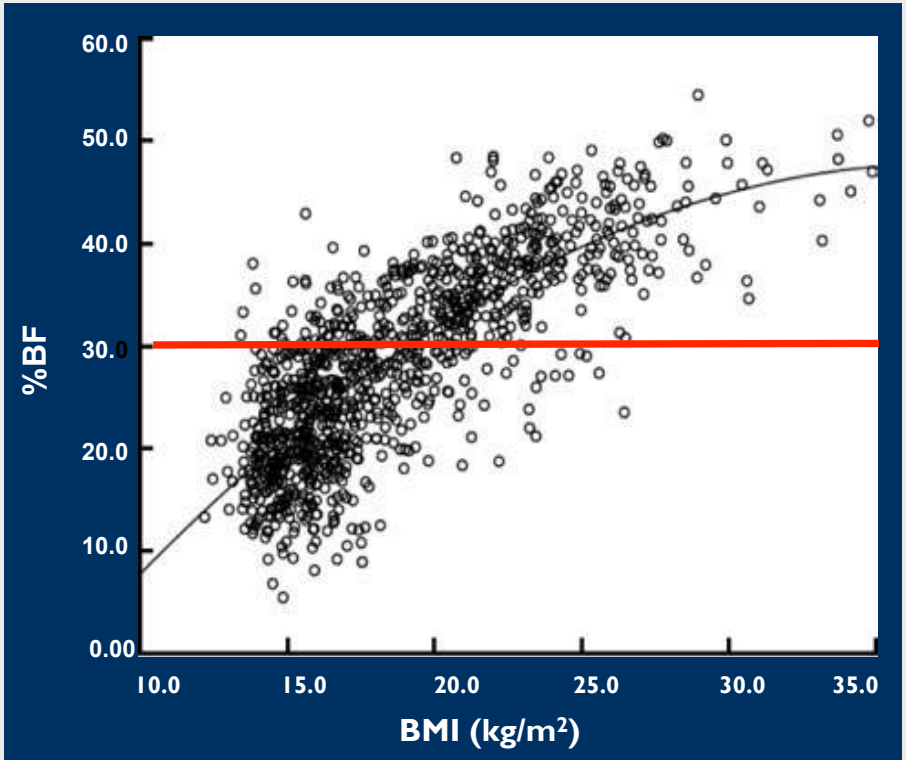
Childhood Obesity And Related Health Risks In Asia And The Pacific (IAEA regional project)

Countries: China, Lebanon, Malaysia, Philippines and Thailand

Participants: 1039 children age 8-10 years

Technique: Body composition using deuterium dilution technique

Conclusion: Necessity to consider ethnic differences in body composition when developing body mass index (BMI) cut-off points and other obesity criteria in Asian children



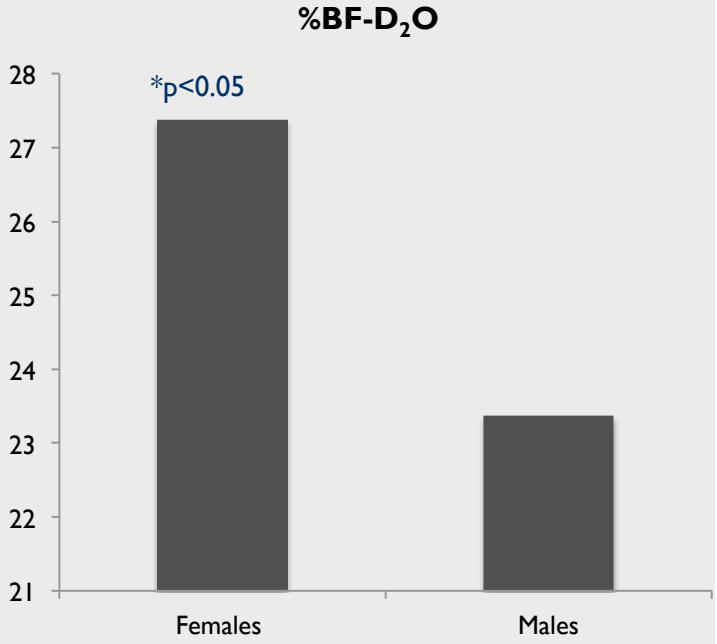
Scatter plot of percentage body fat (%BF) against BMI

BMI cut-offs for Asian children should be lowered when BMI is used as screening tool for overweight and obesity

Source: LIU A et al, Br J Nutr 106 (2011) 1390-7

Assessment of adiposity and association with risk factors for NCDs in Latin American children (IAEA regional project)

- Body composition using deuterium dilution technique in 1,205 children age 6-12 years, 12 countries in Latin America and the Caribbean
- **Significant association of %BF with: blood pressure, blood lipids (TC, HDL, LDL), insulin and immune factors (CRP, IL-6)**



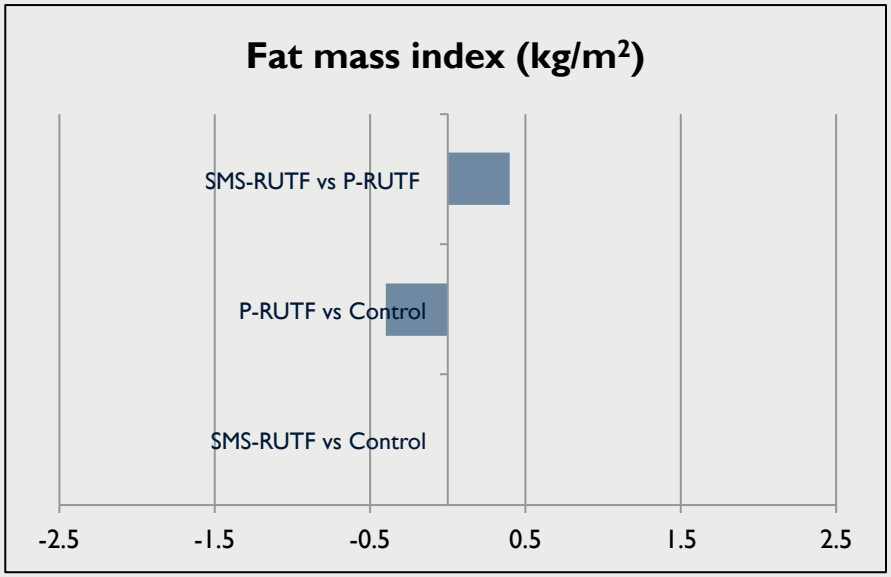
Symposium recommendation

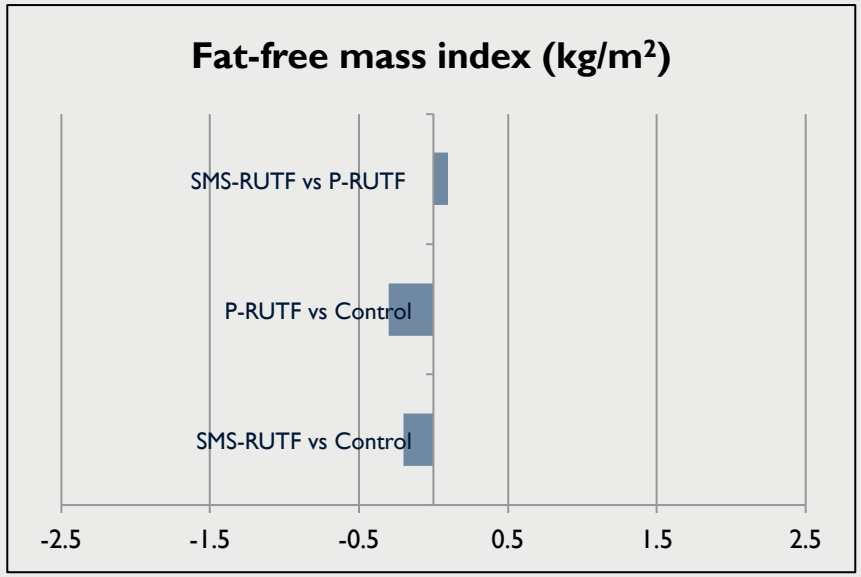
- Go beyond weight change as measure of success, need to assess body composition and metabolic indicators

Recovery from malnutrition

Example from Democratic Republic of Congo

- **Comparison of the efficacy** of soya-maize-sorghum RUTF (SMS-RUTF) with that of standard peanut paste based RUTF (P-RUTF) **in children 24-59 months old** with SAM
- **Differences in body composition** attributable to the 2 products measured at discharge/recovery; comparison with non-malnourished community control
- No significant differences in FM/FMI - both RUTFs not associated with an excess of fat deposition
- Recovery was the same for both products in children >24 months





Control: n=47

SMS-RUTF: n=29

P-RUTF: n=26

adapted from: Bahwere *et al*, *Am J Clin Nutr* 2016;103:1145-61

Effectiveness of food supplements in increasing fat-free tissue accretion in children with moderate acute malnutrition: A randomised 2 × 2 × 3 factorial trial in Burkina Faso

Christian Fabiansen, Charles W. Yaméogo, Ann-Sophie Iuel-Brockdorf, Bernardette Cichon, Maren J. H. Rytter, Anura Kurpad, Jonathan C. Wells, Christian Ritz, Per Ashorn, Suzanne Filteau, André Briend, Susan Shepherd, Vibeke B. Christensen, Kim F. Michaelsen, Henrik Friis

Published: September 11, 2017 • https://doi.org/10.1371/journal.pmed.1002387

PLOS MEDICINE

Photo: K Michaelsen

Why was the study done?

- Are lipid based (LNS) and corn-soy based (CSB) supplements equally effective?
- Are milk and soy based supplements equally effective?
- **Do MAM children who receive LNS accumulate too much fat while gaining weight?**

What did the study do?

- 6-23 old children with MAM, n=1609, Burkina Faso
- Effectiveness of:
  - Feeding LNS vs CSB on weight gain and FFM
  - Feed composition: soy (and its quality) vs dry skimmed milk (and its quantity)
- Main outcome: **Body composition by deuterated water (FFM gain)** in addition to weight
- Measured at enrolment and after 12 weeks

What did the study find?

- Overall, with all supplements, mean weight gain= 0.90 kg (95% CI 0.88, 0.93; $p < 0.01$)
- Higher recovery rate for LNS vs CSB
- **Mean FFM composition of this weight gain = 93.5% (95% CI 89.5, 97.3)**
- **FFMI accretion was slightly higher with LNS feeding: no excess fat gain**

New IAEA regional project: Follow-up of MAM and SAM children (2016-2019)

- **Objective:**
  Evaluate impact of MAM and SAM treatment programmes on health outcomes to improve understanding of relative success of current approaches

- **Measurements:**
  1) Body composition - sensitive measure of nutritional status (body fat and lean body tissue)
  2) Markers of metabolic syndrome

- **Countries** with existing cohort of children: Burkina Faso, Kenya, Ethiopia, Malawi, Uganda, Tanzania, Zambia, DRC

Applying Nuclear Techniques to Understand the Link between Early Life Nutrition and Later Childhood Health (new IAEA 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

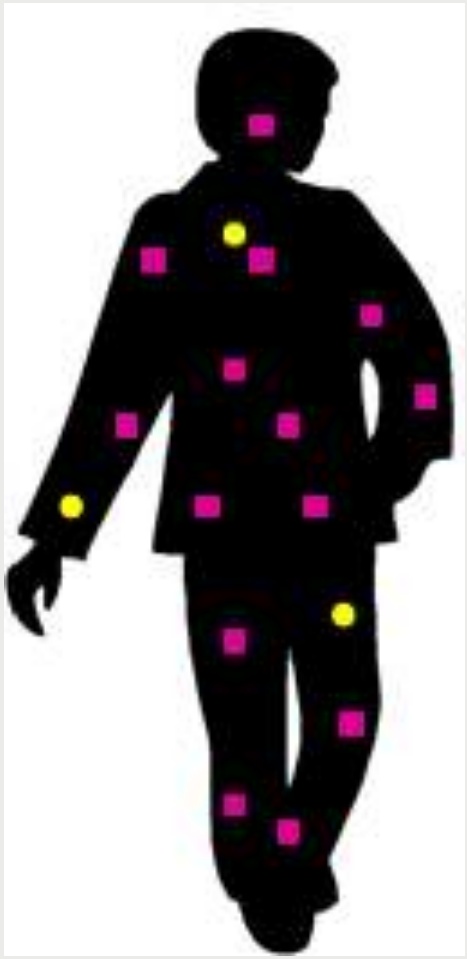
Infancy	Childhood

Cohort D – No intervention received

Preconception	Pregnancy	Infancy	Childhood

Body composition by deuterium dilution – how does it work?

1. Collect baseline sample before drinking accurately weighed dose of deuterium that mixes with body water evenly within a few hours; collect 2 post-dose samples (3-4 h in saliva; 5-6 h in urine)
2. Measure deuterium abundance before and after equilibration of the dose
3. Calculate total body water and fat-free mass using appropriate hydration factor
4. Determine amount of fat mass as difference between body weight and fat-free mass (2-compartment model)



CHALLENGES

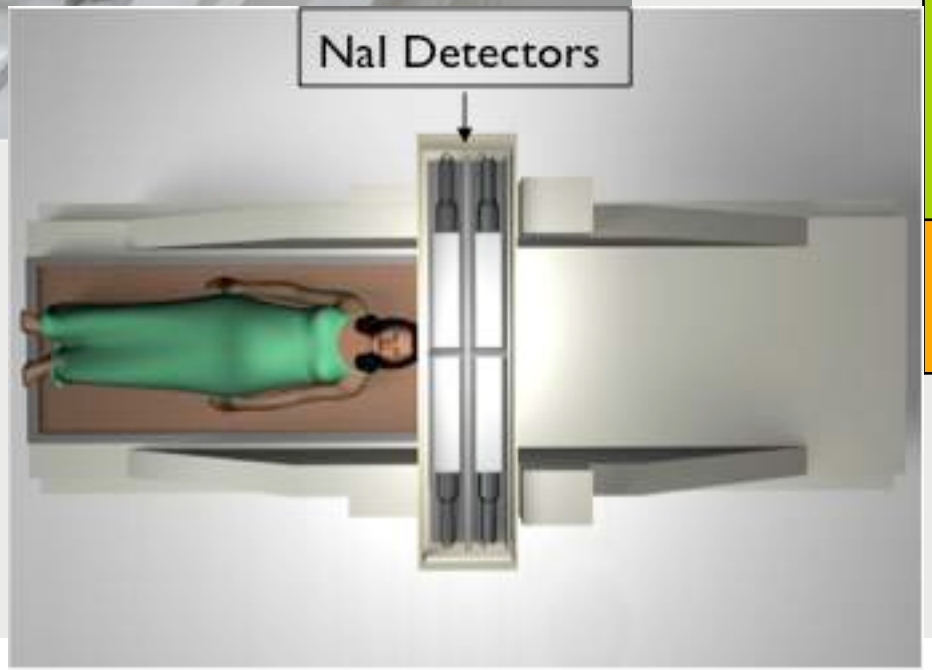
- **Hydration factor**
  - Varies with growth and physiological states
- **Reference data**
  - Will it be possible across different ethic groups?

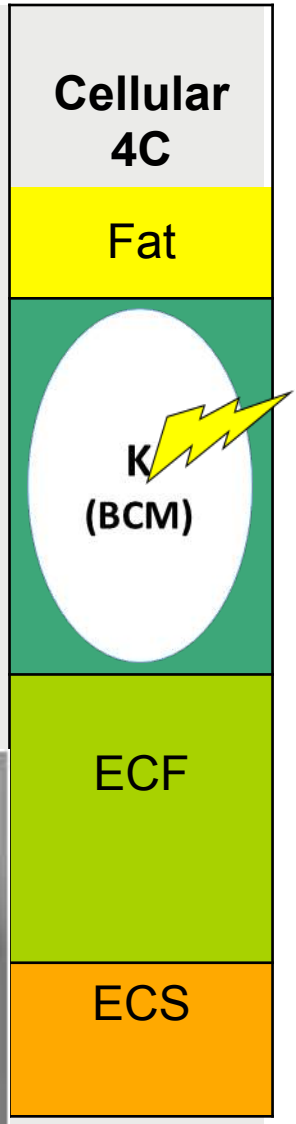
SOLUTIONS

- Body Cell Mass
- Muscle Mass
- IAEA Coordinated Research Project to produce reference charts from birth to 2 years of age

Shadow Shield-Whole body potassium counter
Counting natural ^{40}K in the body as an index of body cell mass

Picture Courtesy: Dr Rebecca Raj





Deuterated Creatine – Muscle mass

American Physiological Society | Journal of Applied Physiology

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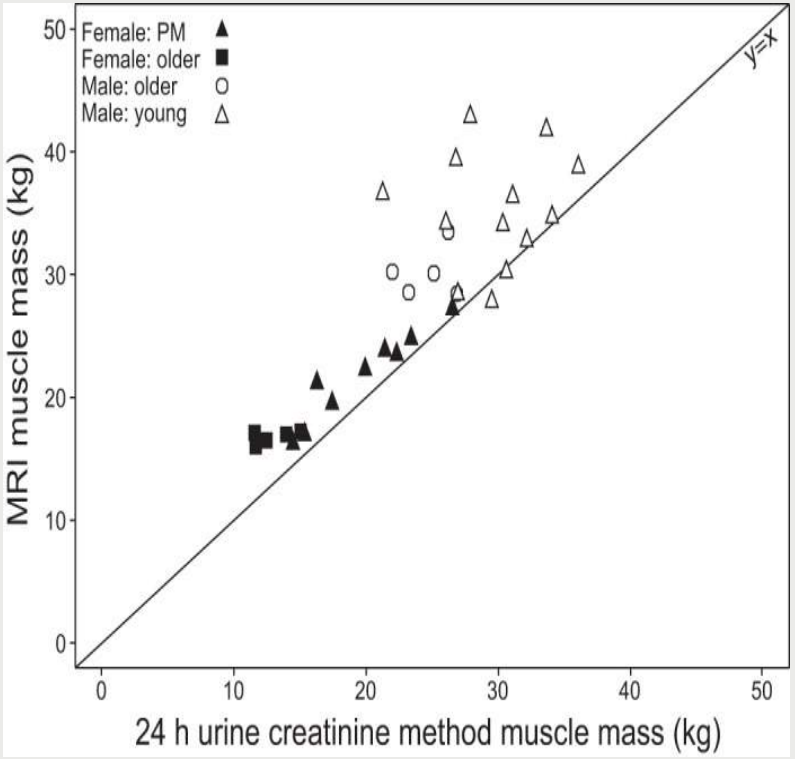
J Appl Physiol (1985). 2014 Jun 15; 116(12): 1605–1613. PMCID: PMC4064374
Published online 2014 Apr 24. doi: 10.1152/japplphysiol.00045.2014

Total body skeletal muscle mass: estimation by creatine (*methyl*-d_3) dilution in humans

Richard V. Clark,[✉1] Ann C. Walker,[1] Robin L. O'Connor-Semmes,[1] Michael S. Leonard,[1] Ram R. Miller,[1] Stephen A. Stimpson,[1] Scott M. Turner,[2] Eric Ravussin,[3] William T. Cefalu,[3] Marc K. Hellerstein,[4] and William J. Evans[2]

- Deuterated creatine measure not affected by hydration
- D3-creatine (*methyl*-d3) used to trace the creatine pool size
- Assume 95% of body creatine is within muscle
- Conversion:
  Muscle mass = creatine pool size/4.3 g/kg
- Correlates well with MRI estimates of muscle mass in adults



Accessible technology – 2D Cell Phone Apps

The Selfie body composition demonstration app makes monitoring body composition accessible!

IAEA partners with University of California, San Francisco

Selfie Cell Phone

Courtesy of John Shepherd, UCSF

Announcement for 2018

IAEA in collaboration with WHO and UNICEF:
Conference on the Double Burden of Malnutrition
10-12 December 2018
IAEA, Vienna, Austria

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Courtesy: St John's Research Institute