

Organ Dose Variability with Gender, Age and BMI

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Background

- The ICRP system uses a generalised, gender and age averaged weighting factors to convert absorbed dose to equivalent dose and effective dose
- These represent the risk of radiological detriment (5% per Sievert)
- Individuals have specific age and gender, thus effective dose is not **directly** representative of an individual's risk
- Effective dose is an input to population protection decisions for managing exposures prospectively, and for assessing risks for generic populations retrospectively
- Effective dose is of limited practical use for providing an individual with an understanding of their radiological risk

Communications and Planning?

- There is a broad “public” assumption that children are more sensitive risks from radiation exposure than are adults
- Protection of children is extremely high on the list of “values” that drive radiological protection decisions.
- Parents are concerned with risk to their children

RP Toolbox

- A better understanding of how effective dose relates to an individual's risk is needed
- It could be useful for discussions with:
 - parents in post-accident situations
 - patients
- The CRPPH is investigating part of this issue: Variability of organ dose with age, gender and BMI

Organ Dose Variability Project

Objective: To model the range of variation in external-source organ dose with gender, age and BMI.

- **Tasks:**

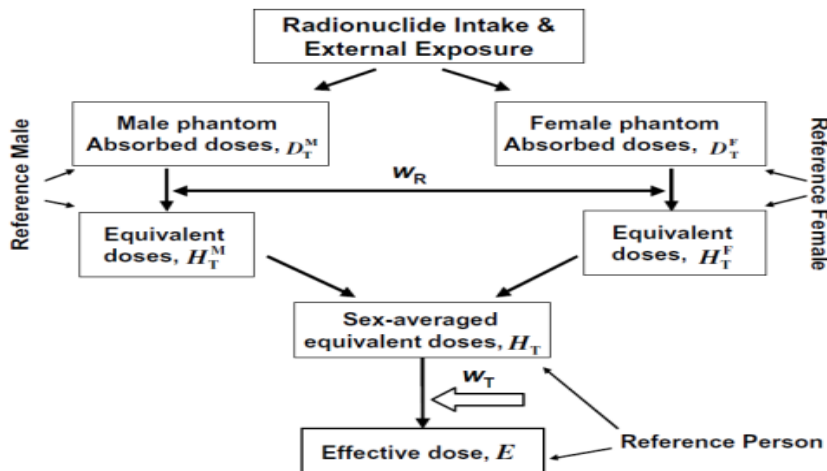
- Use UF phantom library to study the variability of organ dose with age, gender, BMI
- Compare results with those of ICRP representative phantoms
- Compare results with those of other phantom libraries
- Compare results with those of “voxelised CT scans” of real individuals
- Explore organ dose uncertainty in individuals by varying phantom organ size and shape

Project Participants

Work being performed by:

- Dr Wes Bolch, University of Florida
- Dr Shaheen Dewji, Oak Ridge National Laboratory
- Dr Maria Zankl, Helmholtz Zentrum München

Application of Reference Phantoms



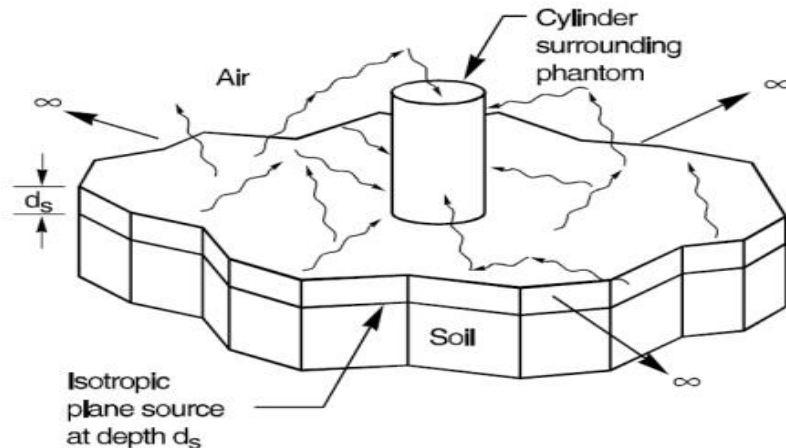
Organ / w_T	ICRP 26	ICRP 60	ICRP 103
<i>Bladder</i>		0.05	0.04
<i>Bone marrow</i>	0.12	0.12	0.12
<i>Brain</i>			0.01
<i>Breast</i>	0.15	0.05	0.12
<i>Colon</i>		0.12	0.12
<i>Endosteum</i>	0.03	0.01	0.01
<i>Esophagus</i>		0.05	0.04
<i>Liver</i>		0.05	0.04
<i>Lung</i>	0.12	0.12	0.12
<i>Skin</i>		0.01	0.01
<i>Salivary Glands</i>			0.01
<i>Stomach</i>		0.12	0.12
<i>Thyroid</i>	0.03	0.05	0.04
<i>Gonads</i>	0.25	0.20	0.08
<i>Remainder</i>	0.30	0.05	0.12

ICRP Publications 89 and 103

Age	Height (cm)		Mass (kg)	
	Male	Female	Male	Female
Newborn	51	51	3.5	3.5
1 year	76	76	10	10
5 years	109	109	19	19
10 years	138	138	32	32
15 years	167	161	56	53
Adult	176	163	73	60

Current Work at University of Florida

- Transport of photons and electrons from emission sites in the environment. These particles are scored (tallied) at the surface of a phantom coupling cylinder
- Step 2 – Re-transport these particles from the surface of the coupling cylinder to different phantoms placed within the coupling cylinder



NOTE

This approach allows efficient consideration of different phantoms exposed to the same radiation environment without having to re-transport particles for each phantom considered.

Non-Reference Phantoms



A



B



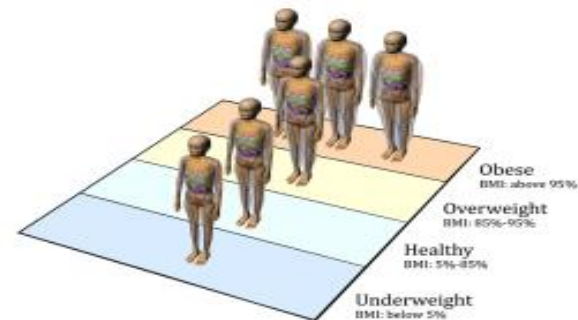
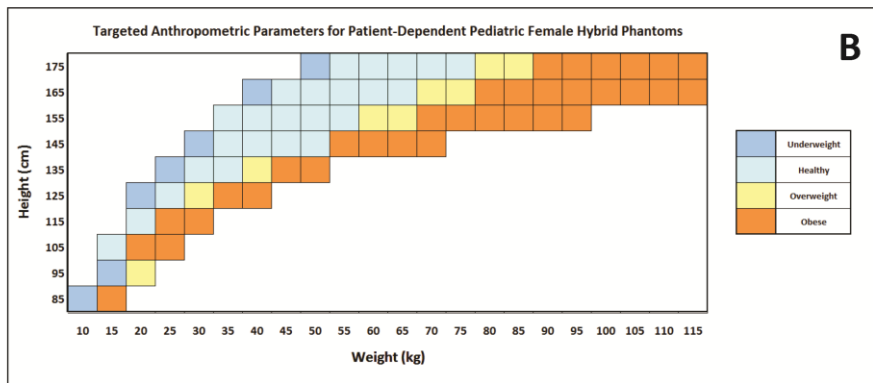
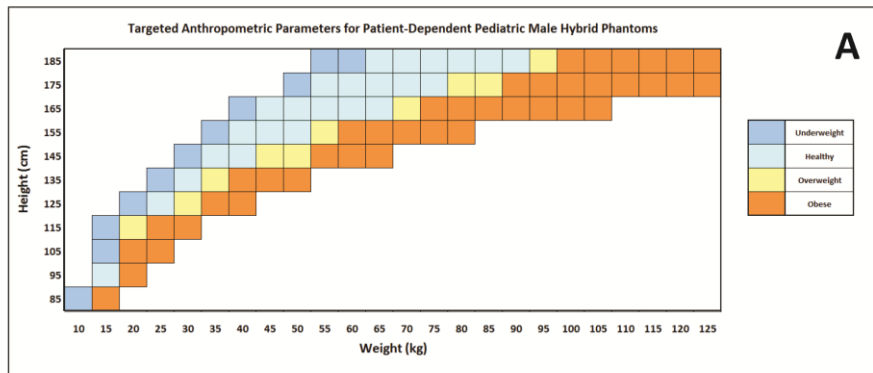
C



D

- A – patient-specific voxel
- B – patient-dependent hybrid
- C – reference hybrid
- D – reference stylised

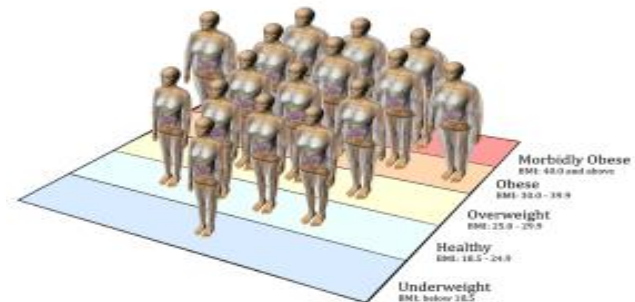
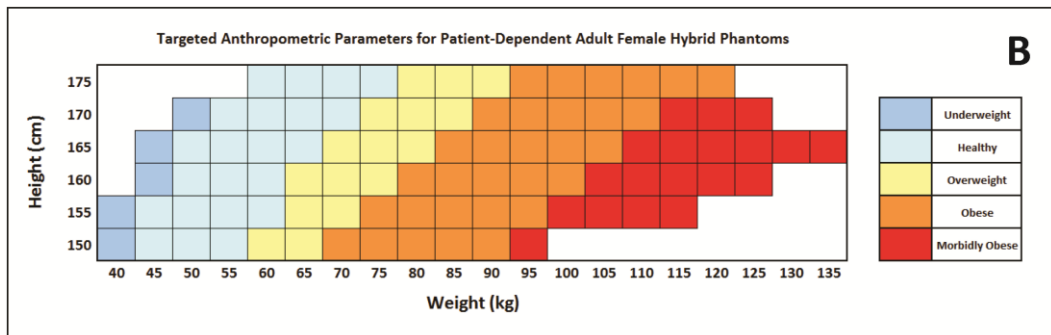
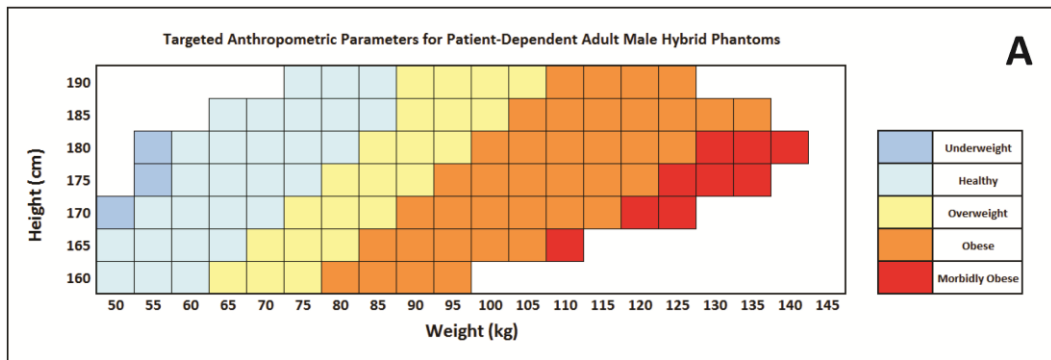
UF/NCI Phantom Library - Children



Phantom for each height/weight combination further matching average values of body circumference from CDC survey data

*85 pediatric males
73 pediatric females*

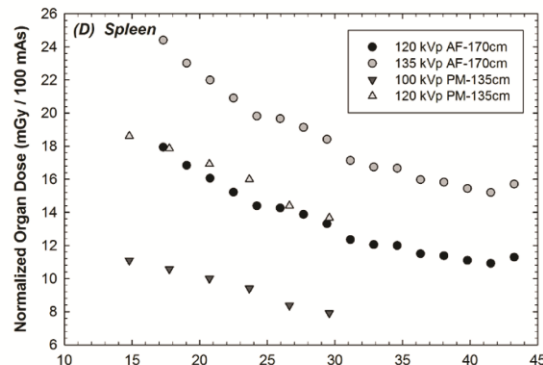
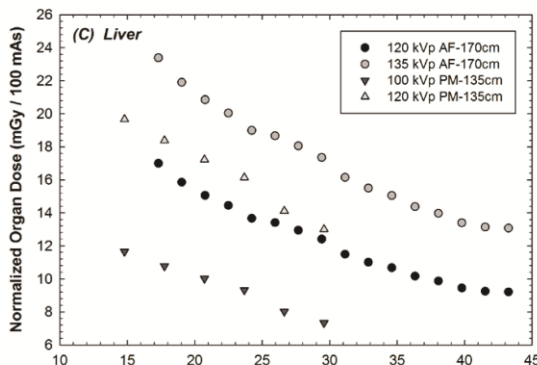
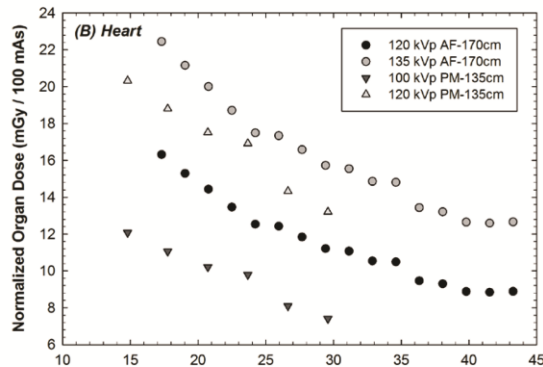
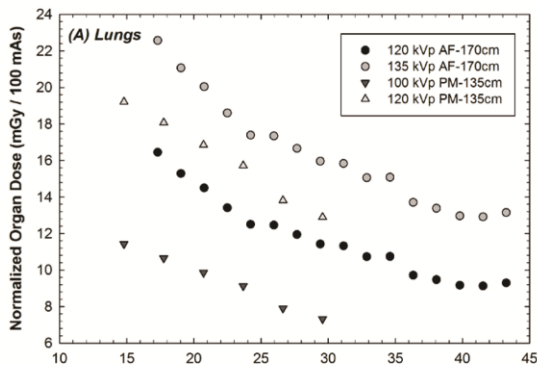
UF/NCI Phantom Library - Adults



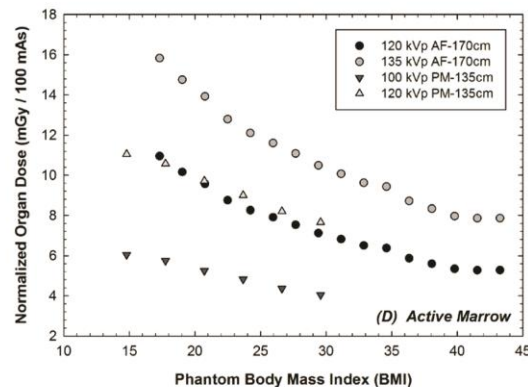
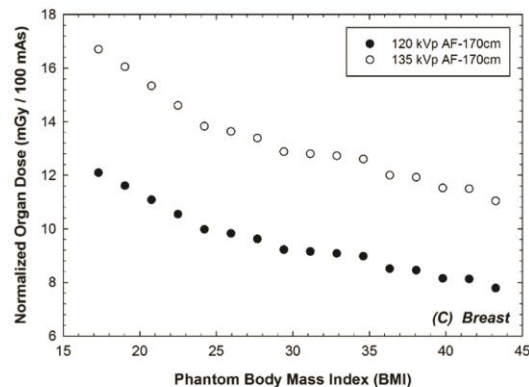
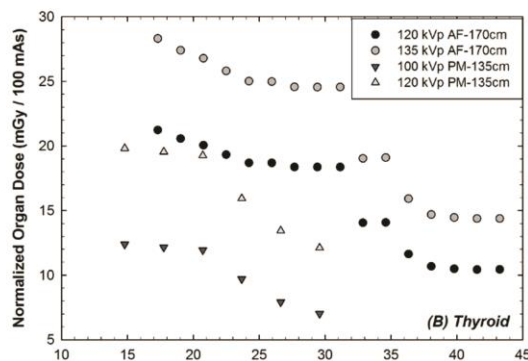
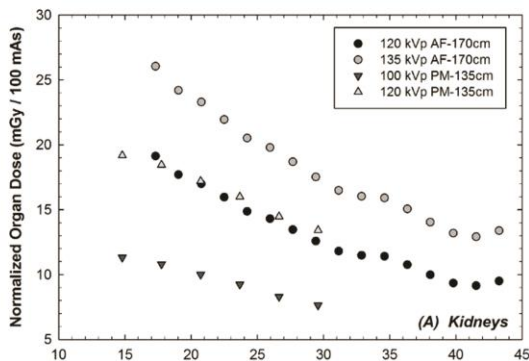
Phantom for each height/weight combination further matching average values of body circumference from CDC survey data

*100 adult males
93 adult females*

Example Calculations – CT Imaging



Example Calculations – CT Imaging



Study Output Objective

- Expanded library of dose conversion coefficients for individual organs
- Organ dose only, not effective dose
- Four sub-libraries over a broad range of gender, age and BMI
 - Adult males
 - Adult females
 - Pediatric males
 - Pediatric females

Study Output Use

- Provide perspective with respect to the variability of organ dose for different types of “individuals”
- Provide more highly “individualised” organ dose values than the 12-member ICRP phantom library
- While based upon U.S. body morphometries, the phantom library is scalable and can thus be applied to any exposed population/nationality

Thank you for your attention



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