Body composition in cystic fibrosis

Paediatric-specific considerations

Results of UK survey on current practices

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Body composition in children with CF

- Risk of *altered* body composition (BC) in CF *(1)*

- Fat-free mass (FFM) deficits > fat mass deficits

- **FFM stronger association with FEV_1 than BMI** *(1,2)*

- Role of fat mass less clear

(1) Calella et al, Nutr. 2018; (2) Gomes et al, Nutr Clin Prac. 2019

‘Hidden fat-free mass depletion’

As yet **no universally agreed thresholds** for normal or low FFM…

Normal BMI

+

Low FFM

→ **Hidden FFM depletion**

King et al 2010 (Australia) n=88 adults with CF
Hidden FFM depletion: more severe lung disease

Ritchie et al. 2021 (US) n=114 children with CF
Hidden FFM depletion: lower FEV1 and lower bone density

King et al, Nutr. 2020; Ritchie et al, J CF. 2021

‘Normal weight obesity’

As yet **no universally agreed thresholds** for normal or high fat mass…

Normal BMI

+

High fat mass

→

Normal weight obesity

Alvarez et al, 2016 (US): n=32 adults with CF
NWO: lower FEV1 & lower FFM

Ritchie et al, 2021 (US): n=114 children with CF
Low prevalence of normal weight obesity

Alvarez et al, Nutr. 2016; Ritchie et al, J CF. 2021

Limitations of evidence

Body composition (BC) studies:

- Wide age ranges and severity of lung disease
- Different methods used
- Mostly cross-sectional
- Inconsistency re. classification of nutritional status

Insufficient evidence:

- Which patients to measure?
- What technique to use?
- Timing and frequency of measurements?
- Interpretation of FFM (and fat mass) values?

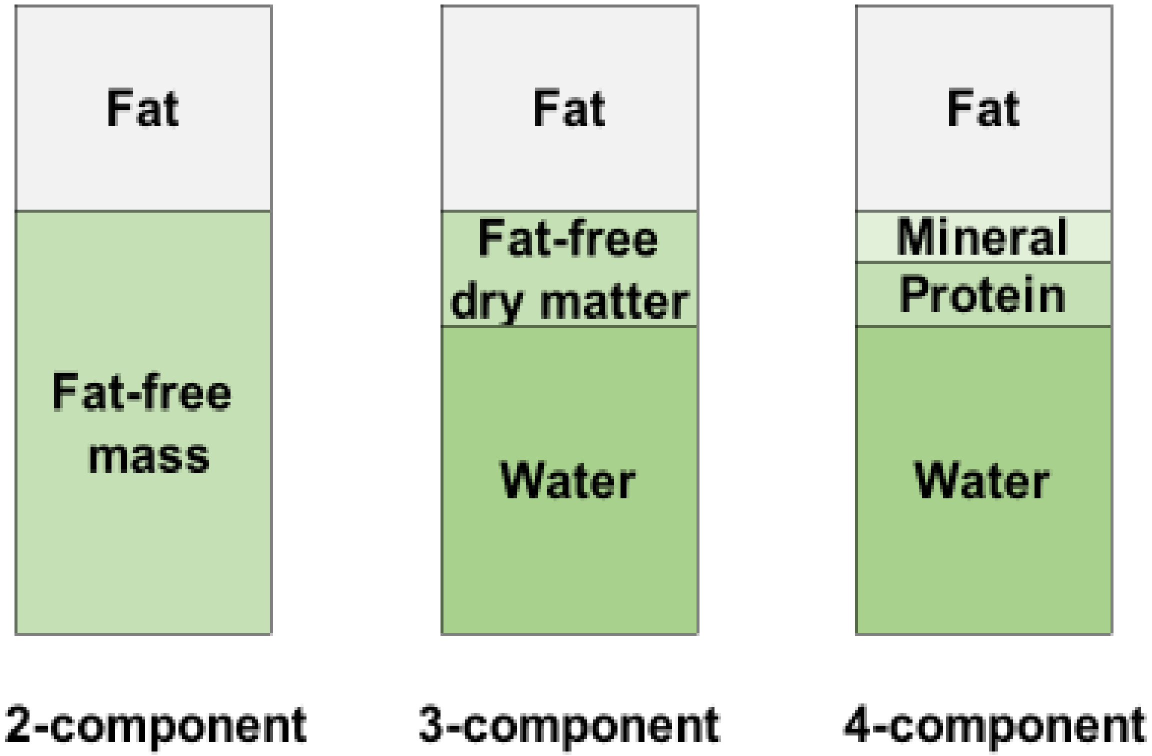
International guidelines for BC assessment in CF

ECFS 2016 ***(3)***	**ANZ 2017** ***(4)***	**US 2020** ***(5)***
Consideration of body composition assessment in all patients	*Consider* in underweight, overweight, obesity or unexplained weight gain	In individuals >8y age: DXA In patients of all ages when DXA not feasible: use MUAC or BIA

DXA: dual energy X-ray absorptiometry
MUAC: mid-upper arm circumference
BIA: bioelectrical impedance analysis

(3) Turck et al, Clin Nutr. 2016; (4) Saxby et al, Thor Soc Aus NZ. 2017; (5) McDonald et al, J Acad Nutr Diet. 2020

Models of body composition



Pros and cons of different techniques

Technique	What it measures	Pros	Cons
Whole body dual energy X-ray absorptiometry (DXA). Uses dual energy X-rays which pass through the patient.	Whole body and regional fat, bone and lean mass. Shows distribution of soft tissue in limbs and trunk.	Widely available. Most accurate measurements are those of the limbs. Low exposure to ionising radiation. Good reproducibility. Acceptable in children as young as four years. Short scan time.	Cost. Lack of portability of equipment. Needs to be performed by trained operator. UK paediatric reference not widely available for clinical use.
Bioelectrical impedance analysis (BIA). Electrodes placed on hands and feet. Impedance to a weak electrical current is measured between the contact points.	Predicts FFM from predicted total body water. Shows direction of change of FFM if used sequentially. Preferably use raw values.	Quick and simple. No radiation. Multi-frequency more accurate than single frequency devices.	Cost of purchasing machine. Limited validation studies in CF. Values for FFM have been predicted from hydration data from healthy populations
Mid upper arm circumference (MUAC), measured using a fibre glass, non-stretch tape.	Measure of regional fat. Take average of three readings. Use sequentially and use raw values.	Quick, simple. Non-invasive. Useful in CF liver disease if enlarged organs. WHO reference data available for children under five years of age.	Does not reflect whole body distribution of fat or quantify. Ideally should be same person doing repeat measurements to minimise inter-operator variability.
Skinfold thickness, measured using callipers.	Predictive measure of regional fat. Take average of three readings at single site. Tricep skinfold shows the most variation during illness. Use raw values.	Quick, easy and cheap to perform.	Operator dependent. Not for obese. Prediction equations based on healthy populations and show variable accuracy in CF.

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Body composition working group

NEW

Develop **standardised practices** and contribute to national guidelines for BC assessment and monitoring in pwCF

Develop **shared resources** for dietitians working in CF to measure BC using different techniques

Aims and objectives of UK survey

- To establish **current practices** amongst dietitians working in CF regarding BC assessment

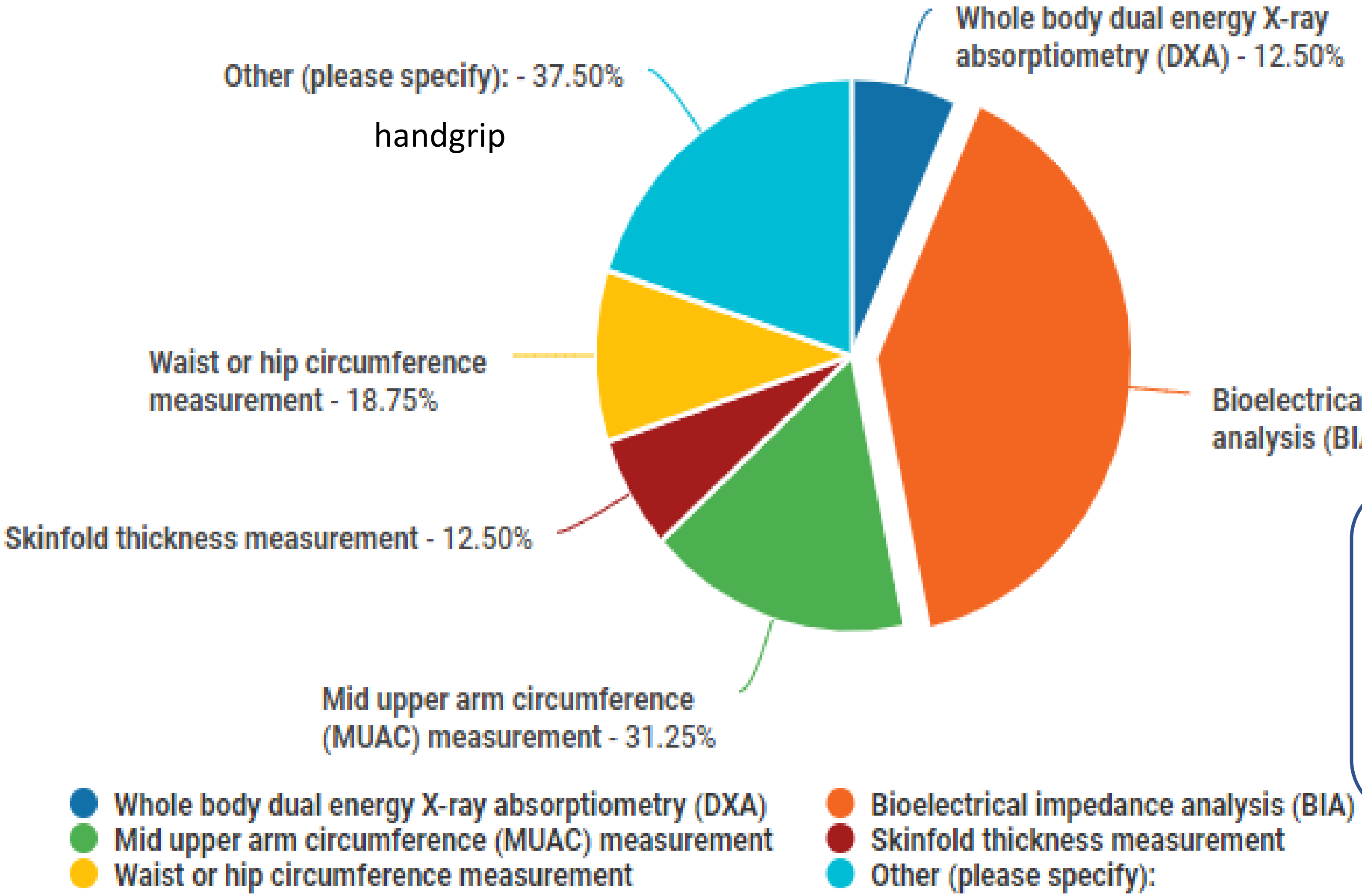
- To identify **gaps in knowledge**, **barriers to doing measurements** and **limitations in interpreting results**

- Online survey circulated to dietitians via BDA CF Specialist group January 2023

36 responses

16/36 dietitians measure BC in practice

Techniques used to measure body composition

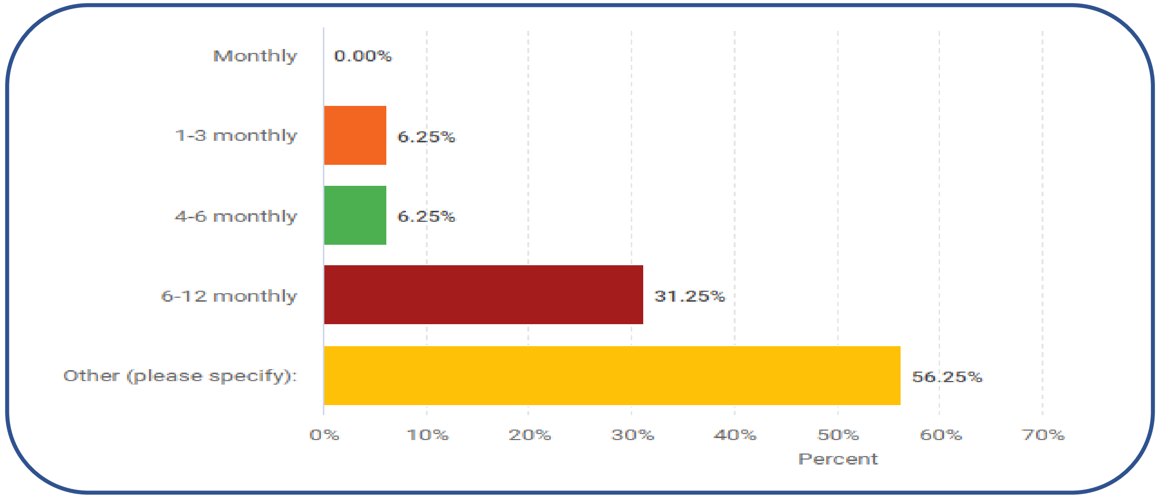


In all 16 centres dietitian does BIA.

In 4/16 exercise practitioner/physio assistant also takes measurements

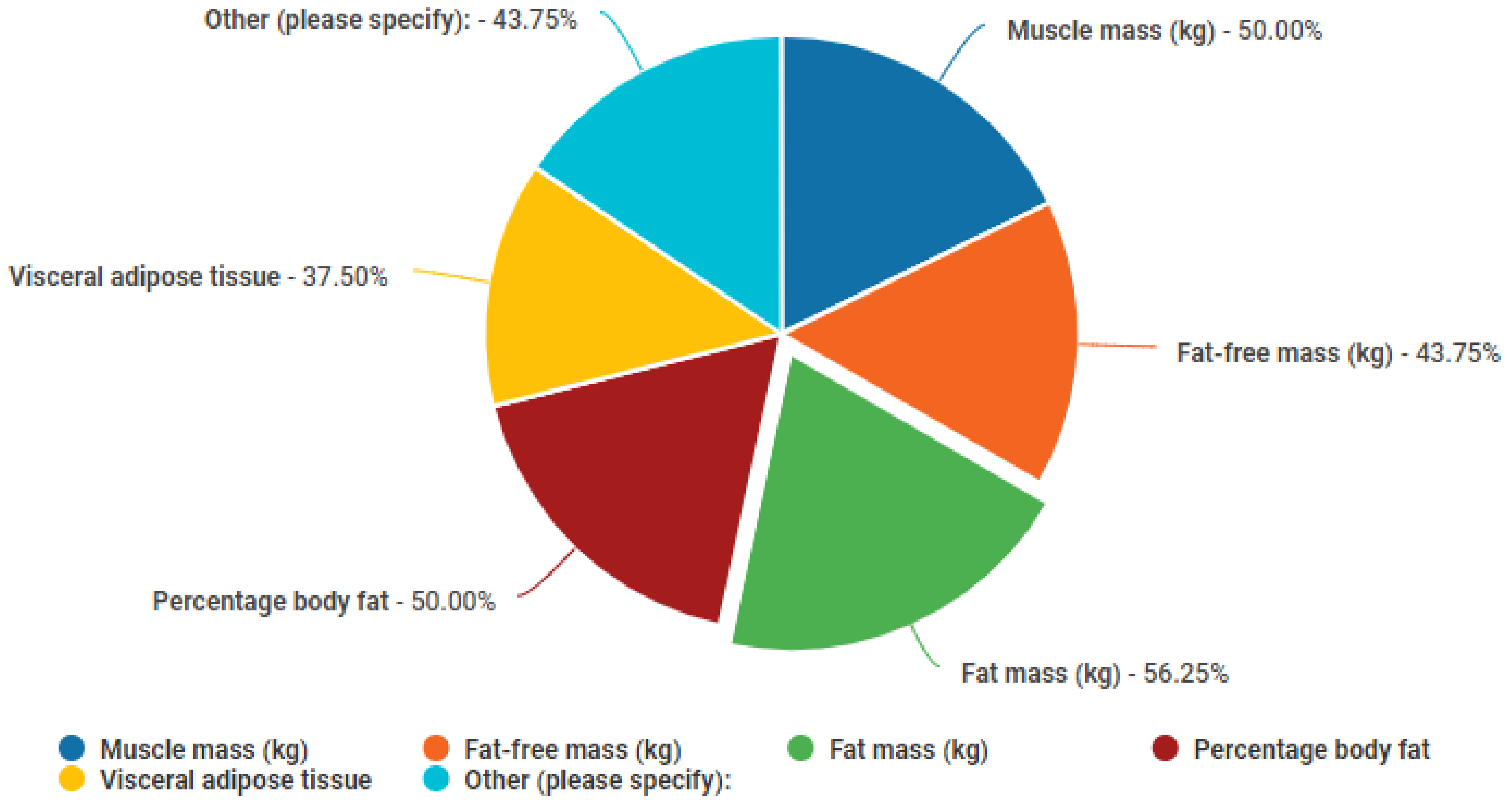
Which patients have measurements and when?

- 10/16 centres measure **all patients**
- 6/16 **targeted**:
  - those with liver disease, malnutrition or awaiting transplant
  - ≥10y age
  - ≥6y age on ETI (pre-post)
  - those starting ETI
  - tube feeding (pre-post)
  - adults only, with consent



- Frequency of repeating measurements: annual assessment or adhoc

Interpretation of results



Nutrition intervention: targeted dietary advice

12/16 dietitians tailor dietary advice to **muscle mass**:

- High energy, high protein diet, rather than standard nutrition support
- Basic **sports nutrition** advice e.g. skimmed milk powder, refuelling after exercise
- Work with **physio exercise team** to meet patients' goals
- **Diet quality**
- Promote regular exercise (resistance), and good **protein** intake (type and timing) as per ISSN

9/16 dietitians tailor dietary advice to **fat mass**:

- **Healthy eating / balanced diet**
- Reduce fat if high fat mass
- If weight is low, encourage **healthy fats**
- If high BMI and high fat mass, reduce calorie intake and increase PAL
- Focus more on improving muscle mass than reducing fat mass

Barriers to doing measurements in practice

- 13/21 lack of equipment
- 7/21 lack of knowledge
- 6/21 lack of time
- 6/21 other: machine not portable

  lack of clinically available reference data in children

  tech. issues not being able to add software to network

  lack of evidence re. most reliable method

  issues with infection control

Resources requested (for dietitians)

- **Consensus** regarding best practice
- Aims and targets for BC, **thresholds of adequacy** (similar to BMI), pros and cons of different methods
- **Interpretation** of measurements against **reference data / paediatric centile charts**
- A **'how to' guide/education package** for taking BIA (and other) measurements
- **SOP** for equipment
- Advice on how to improve BC/**interventions**

Resources requested (for patients)

- Interventions to improve body composition and why it is important (?age-specific)

- Poster for clinic to explain BIA and how it can help you

- More evidenced resources re **exercise nutrition, healthy eating** and **obesity management**

Pros of doing BC measurements

- Shifts focus away from weight or BMI alone
- Provides more **meaningful/detailed assessment** of health status, e.g. low BMI but good muscle mass (reduces level of concern), highlights **normal weight obesity, hidden low muscle mass** etc.
- Helps **motivation / track fitness** and enables targeted exercise advice
- Enables more informed decision about nutritional management
- May help address body image concerns?

Cons of doing BC measurements

- Additional **time** taken to set up device
- Lack of guidance re frequency of doing repeat measurements
- **Validity** of results
- **Interpretation** of results (particularly in children)
- Weight stigma/anxiety/body image issues (body fat) – may trigger unhealthy eating habits?

Future plans for BC working group…

- Work with research team involved with UK2009 paediatric reference data *(6)* to convert into clinically usable form…

- Work with CF Trust and other dietetic working groups +/- CF physio group to modify and update existing patient nutrition fact sheets/ design new BC fact sheet…

- Incorporate (raw measurements?) into UK CF Trust Patient Registry data…

(6) Wells et al. 2012 Am J Clin Nutr.

Effects of ETI on BC in children with CF

- Single centre service evaluation in children 6-11y eligible for ETI.
- Wt, ht and FEV_1. Multi-frequency **bio-electrical impedance (BIA)** to predict skeletal muscle mass (SMM) & fat mas.
- Measurements performed Jan-Dec 2022 before starting & repeated within first 6m on ETI.
- Data converted to z-scores where reference data clinically available: UK 1990 for anthropometry, GLI 2012 for lung function.
- Statistical analysis: Paired *t*-tests compared variables pre-post ETI.

ETI; Elexacaftor-Tezacaftor-Ivacaftor
GLI; Global Lung Initiative

Effects of ETI on BC in children with CF

Baseline & repeat values for anthropometry, body composition & spirometry pre-post ETI

Variable mean (SD)	Wt z-score	Ht z-score	BMI z-score	SMM kg	FM kg	FEV1 z-score
Baseline MN n=19	-0.69 (1.18)	-0.51 (1.26)	-0.38 (1.01)	11.71 (3.72)	4.47 (3.90)	-0.42 (1.09)
Baseline other n=29	0.00 (0.83)	-0.07 (1.14)	0.03 (0.91)	13.00 (3.04)	4.44 (2.02)	-0.49 (0.99)
Repeat MN n=16	-0.60 (1.20)	-0.60 (1.14)	-0.37 (1.06)	12.73** (4.29)	5.43 (4.81)	-0.14* (1.08)
Repeat other n=24	0.08 (0.83)	-0.19 (1.10)	0.10 (1.03)	14.43** (3.79)	4.68 (2.16)	-0.22* (0.88)

*p <0.05, **p <0.001, paired t-test, MN and other modulators group analysed separately.

- No significant differences in anthropometric scores pre-post ETI.
- **Raw SMM values increased significantly pre-post ETI, fat mass did not.**
- FEV1 z-scores increased significantly pre-post ETI.

MN; modulator-naive

Effects of ETI on BC in children with CF

- This younger age group of children do not have significant increases in weight, height or BMI on starting ETI within first 6 months, irrespective of previous modulator use.

- Improved nutritional status appears evident with **increased skeletal muscle mass**, rather than fat mass.

- These data are **limited** by a lack of controls & **clinically usable UK paediatric body composition reference values**. Further work is needed to address this & to establish clinically meaningful thresholds of adequacy.

- Diet and exercise advice should focus on promotion of skeletal muscle mass for improved FEV_1, whilst achieving or maintaining optimal BMI.

Workshop: Paediatric-specific issues

- Use standardised techniques and calibrated equipment
- Consider inter- and intra- user error
- Consider practical issues when measuring young children
- Serial measurements more useful than single measurement
- Interpret results in conjunction with other growth parameters
- Use reference data where possible