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Nutritional assessment in practice- current & future

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Health outcomes & nutritional assessment

(BDA Model for Dietetic Outcomes 2011)



- Health outcome defined as:
‘A change in the health of an individual, group of people or a population which is attributable to an intervention, or series of interventions’
- Patient satisfaction (patient reported experience measure) in itself does not demonstrate a clinical therapeutic change & by itself cannot measure the effectiveness of an intervention.
- Fundamental principles of a health outcome measure are validity, reliability & responsiveness measured over a specific period of time.
- Defining and measuring outcome measures matters more than ever in order that we can demonstrate as a profession (added) value, performance improvement, accountability etc

Dietetic outcome measures (BDA 2011)



- Should be SMART:
 - **S**pecific
 - **M**easurable (must be readily observable & measurable)
 - **A**ppropriate
 - **A**cceptable to the clinician & patient
 - **R**eliable- consistent measures across time & organisations
 - **T**argeted- clear what it is focused on
- Suggested outcome domains:
 - Symptom
 - **Physical (anthropometry)**
 - Biochemical
 - Psychological
 - Behaviour change
 - Patient focused
- At the end of an episode of care an evaluation should be made as to whether its been achieved, partially achieved or fully achieved

Current clinical practice



- Anecdotal evidence along with evidence from clinical audits suggests that current anthropometrical assessment primarily focuses on:
 - weight,
 - height (measured, self reported, derived from surrogates),
 - BMI,
 - changes in weight

Components of body weight (Smith 2010)

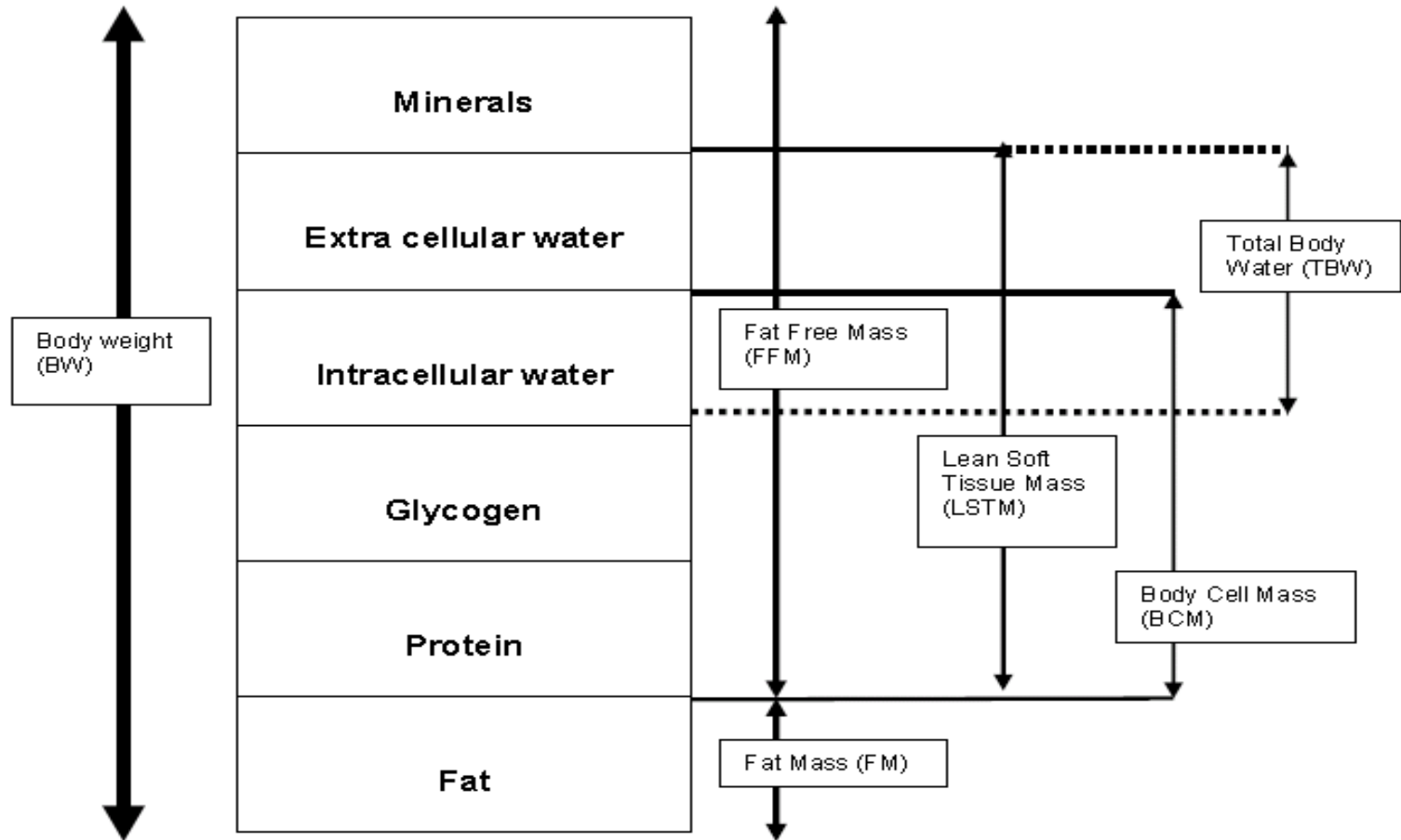


Figure 1.1: Components of body weight (adapted from Kyle 2004, Cano et al 2009)

Undernutrition and nutrition support



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Degree of depletion, +/- the distribution of FFM/LBM directly correlates with increased risks eg

- increased length of stay,
- functional impairment,
- poor immune function,
- poor wound healing,
- poor quality of life,
- Increased risk of mortality

Measurement of weight in practice

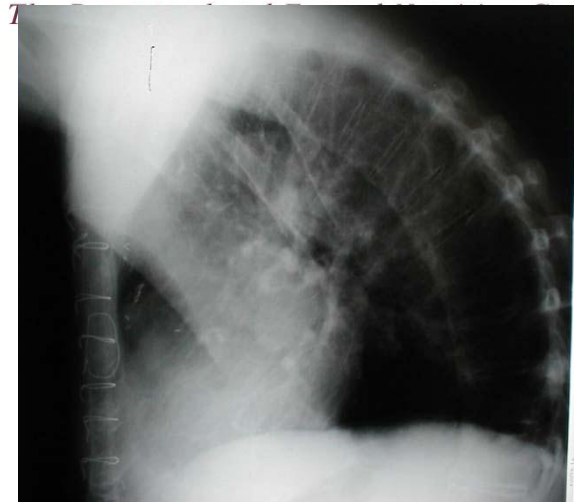
- Unavailable in a significant proportion of patients
- Lack of equipment or inappropriate, non-calibrated equipment
- Inconsistent use of equipment and/or standard protocols
- Acutely & significantly affected by changes in hydration
 - Estimation of dry weight in the presence of ascites & oedema (Watson & Watzl 1992) provide a guide only and there is much individual variation

Ascites	Severe (Tense) 14.0kg Moderate 6.0kg Minimal 2.2kg
Peripheral Oedema	Severe 10.0kg (up to sacrum) Moderate 5.0kg (up to knee) Minimal (Mild) 1.0kg (ankle)



Measuring height in clinical practice

- Measurement of height can be difficult to obtain due to patients being too ill, bedbound, having poor balance, or a degree of disability.
- Alternative surrogate measures of height include knee height, ulna and demispan can and are used.
 - BUT all surrogate measures (Demispan, Ulna length, knee height) found to be inferior to self reported height (MUST Report BAPEN 2003).
 - severe or obvious curvature of the spine (kyphosis or scoliosis) can affect demispan measurements
- Use of surrogate measures may affect the calculation of BMI and therefore classification and possible treatment:
 - **Tend to overestimate height and underestimate BMI with a mean difference of -1.79Kg/m^2 (Kwok & Whitelaw 1991)**



Body Mass Index (Quetelets Index)



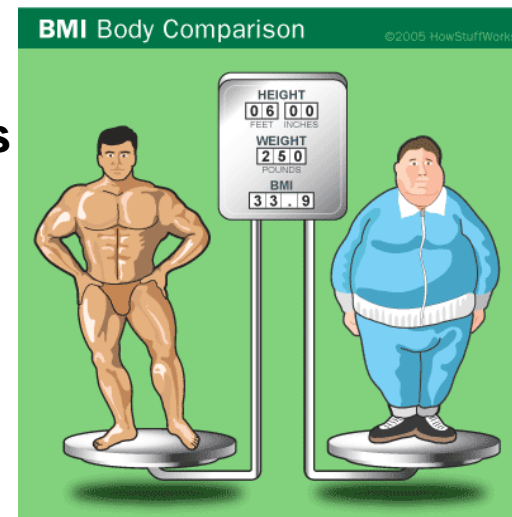
BMI is considered to reflect chronic protein energy status and remains a widely used indicator of nutritional risk.

- BUT doesn't tell us anything about body composition (FM v FFM) or patterning of FM /FFM.

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Constantly argued that at an individual level BMI provides misleading information in:

- Infancy/ childhood
- Ageing (for same BMI > FM in older people)
- Ethnic populations (diff segmental proportions of length & mass)
- Athletes (> FFM stores)
- Military/civil forces personnel weight loss +/- exercise,
- Physical training/activity
- Particular clinical situations (eg lipodystrophy in HIV, situations where large changes in tissue hydration are seen)
- Kyphosis- decrease in 5cm in ht with initial BMI of 20-25 will increase BMI by 1.1-1.5kg/m²



Use of Circumferences & skinfolds



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- Anthropometry has an important place in nutritional assessment as it remains one of the few methods available in clinical practice for assessing FM and FFM (used to derive MAMC) in individuals.
- Also suggested that the quantification and patterning of skeletal FFM is more useful and relevant to activities of daily living when considering the efficacy of nutritional interventions rather than the quantification of total FFM.
- However widely known that intra observer measurement error can influence both the actual measurement and interpretation of changes.
 - Therefore it is important to be aware of intra observer measurement error and to take steps to minimise any such error by following standard protocols and practising the techniques.
 - Individual intra observer measurement errors can be quantified by calculating the technical error of measurement (TEM), which is the square root of the measurement error variance (Ulijaszek & 1999)

Use of MAC to predict BMI or derive weight in those who can't be heighted or weighed



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- Powell-Tuck & Hennessy (2003) work demonstrated a significant positive correlation between MUAC & BMI
- Produced regression equations which have been widely used to predict BMI
- Secondary analysis of data for individuals who participated in the National Diet & Nutrition Survey suggested substantial variation in BMI predicted from an individual MAC
- Pilot data in a young healthy female population has also found this (Houghton & Smith BAPEN 2011)
 - As per BAPEN guidance a general cut off value should be used to identify underweight individuals and obese individuals as follows:
 - < 23.5 cm to identify those with a BMI <20kg/m² (and a BMI <18.5kg/m²)
 - > 32 cm to identify those with a BMI >30kg/m²

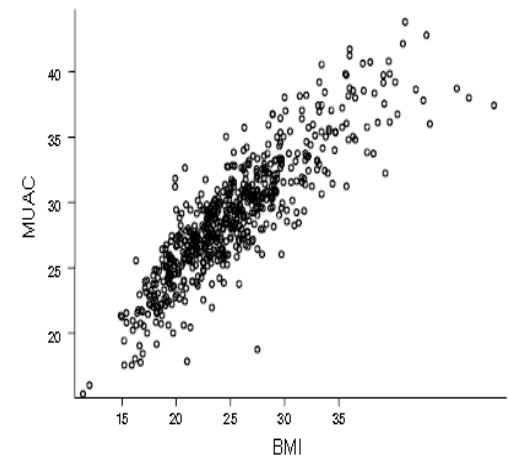


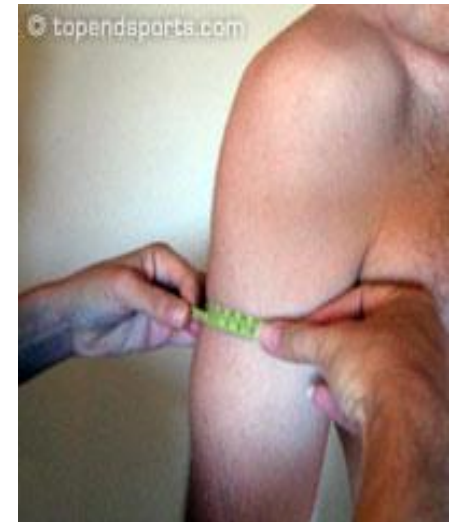
Fig. 1. MUAC vs BMI—all patients.

Mid (upper) arm circumference (MAC/MUAC)

- Indirect measure of both adipose and lean tissue and therefore similar to BMI
 - Decrease in MAC can either be due to loss of FM or FFM
- Increases in MAC correlates with weight gain per se
 - eg 10% change in MAC will correspond with 10% change in body weight
- Less affected by oedema-therefore allows improved interpretation of weight changes
- Simple, minimally invasive, requires little patient co-operation
- Possible to measure in supine position (Ravasco et al 2002)
- Minimal equipment necessary (tape measure)
- Intra and inter agreement is high at both extremes of body composition



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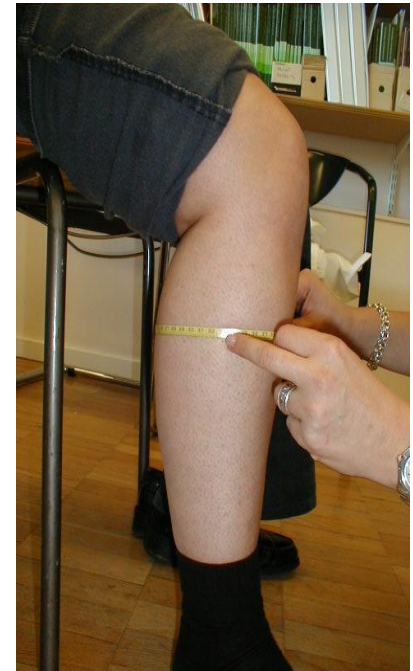


Calf Circumference (CC)



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- WHO have suggested that calf circumference (CC) is a more sensitive indicator of total FFM losses particularly in older adults.
- May also be a better predictor of total FFM than MAMC (Martin et al 1990, Smith et al 2005).
- CC has been shown in to be positively associated with disability and self reported function:
 - Rolland et al (2003) retrospective analysis of 1458 elderly french women demonstrated that CC correlated with appendicular skeletal muscle mass & was associated with disability and self reported physical function
 - Stewart et al (2002) study of 288 female volunteers aged >70 years demonstrated a correlation between CMC and incidence of falls
- CC can be performed on either calf, but the right calf is preferred.
- Can be taken in a sitting position with the leg at a 90o angle.
- Reference data/centiles are available for CC eg
 - US NHANES data, Corish & Kennedy (2003).



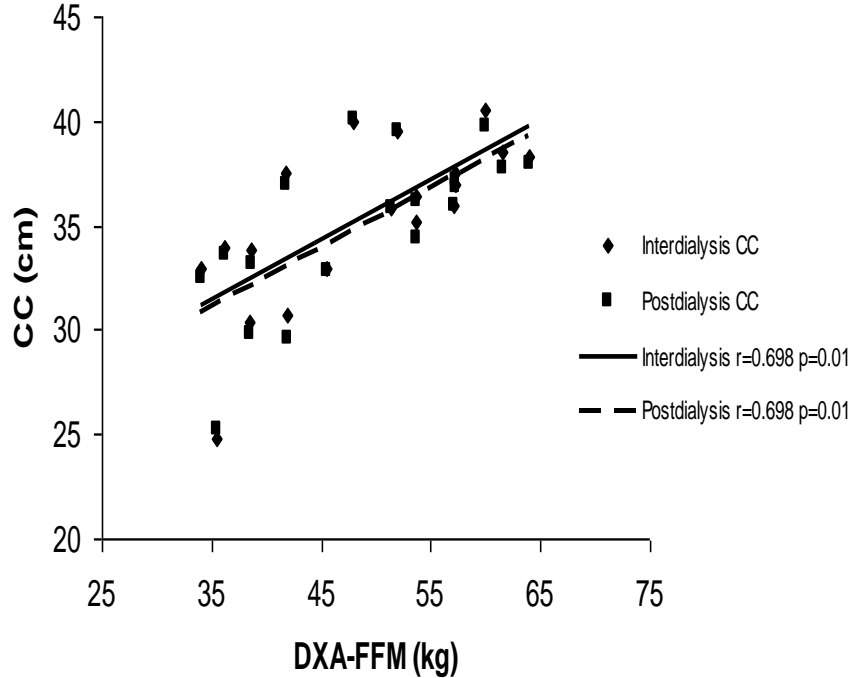
CC, AMC & relationship with whole body FFM

(Smith et al 2004:Proceedings of the Nutrition Society,64 (suppl 1B): 2A)

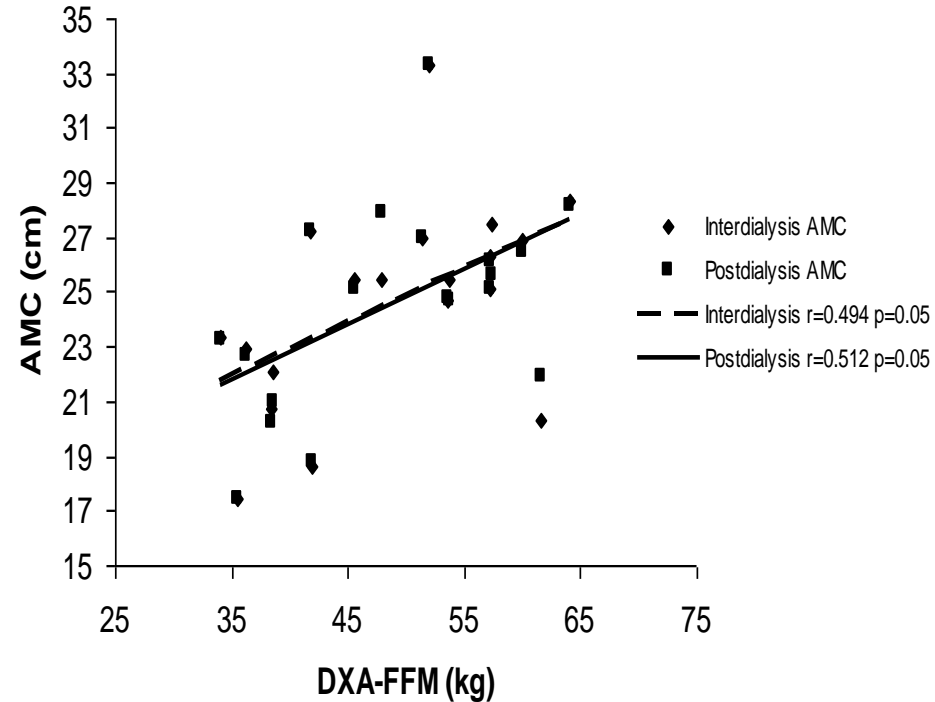


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Association between DXA-FFM and CC



Association between DXA-FFM & AMC



Handgrip Dynamometry/ Grip Strength



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- Measure of upper extremity muscle function/strength positively correlates with cardiovascular mortality, morbidity and with FFM (Payette et al 1998, Figueiredo et al 2000, Heimburger et al 2000, Wang et al 2005)
- Although FFM *per se* is a major determinant in muscle function it isn't the only factor as muscle function responds earlier to both nutritional deprivation and nutritional repletion than parameters such as muscle mass (FFM) or total body mass (Norman et al 2010)
 - Factors such as electrolyte status or changes in insulin stimulated glucose uptake appear to be more responsible for the early changes than changes in muscle mass.

Russell et al 1983,Am
J Clin Nutr (38): 229

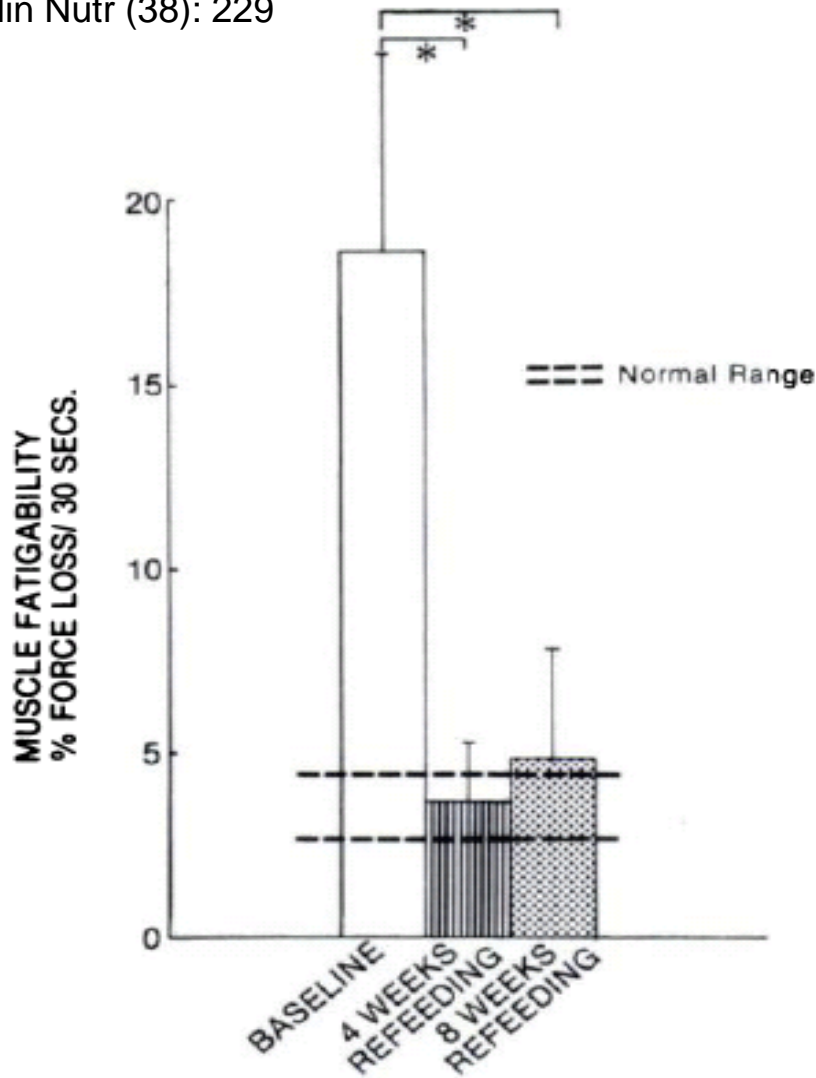


FIG 2. The *bar graphs* represent the mean \pm SEM muscle fatigability. The *brackets* above the bar graphs indicate the significant changes during refeeding. * $p < 0.05$. The *dotted lines* represent the previously reported normal range. (5).

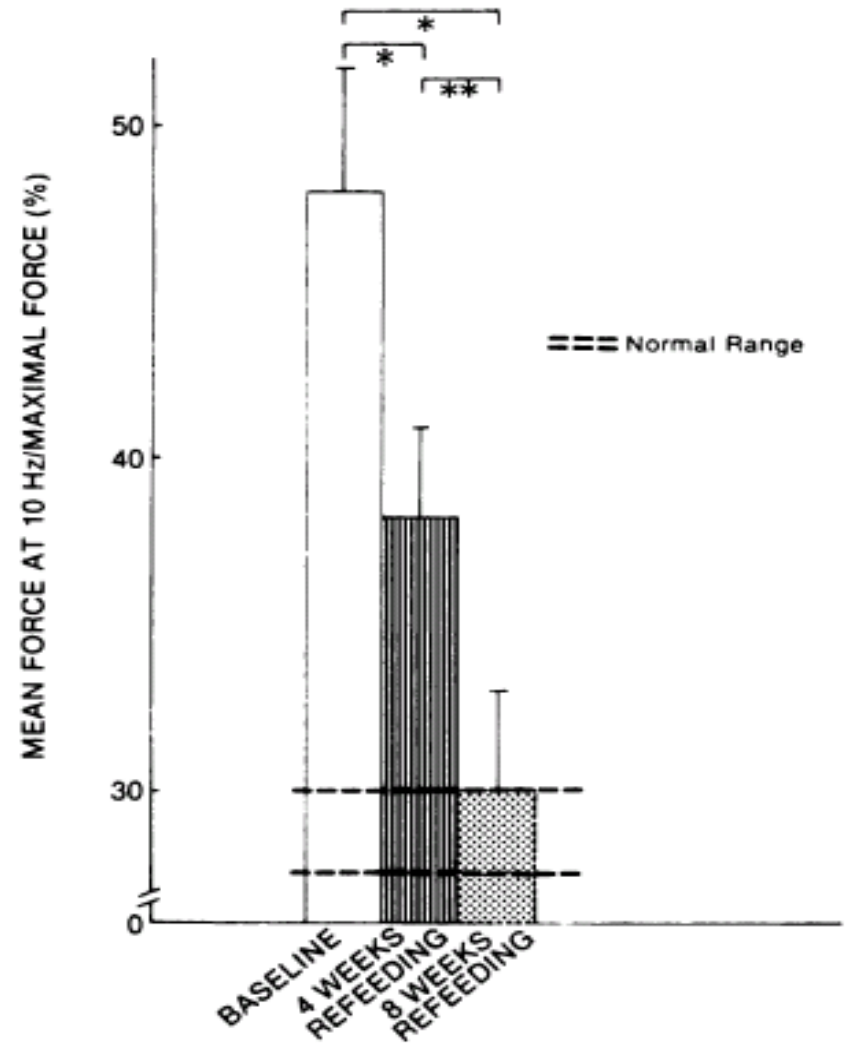


FIG 3. The *bar graphs* represent the mean \pm SEM force at 10 Hz stimulation (expressed as a percentage of the maximal force). The *brackets* above the graphs indicate the significant changes during refeeding. * $p < 0.025$, ** $p < 0.05$. The *dotted lines* represent the previously reported normal range (5).

Changes in body composition as a result of feeding in AN



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Russell et al 1983, Am J Clin Nutr (38): 229

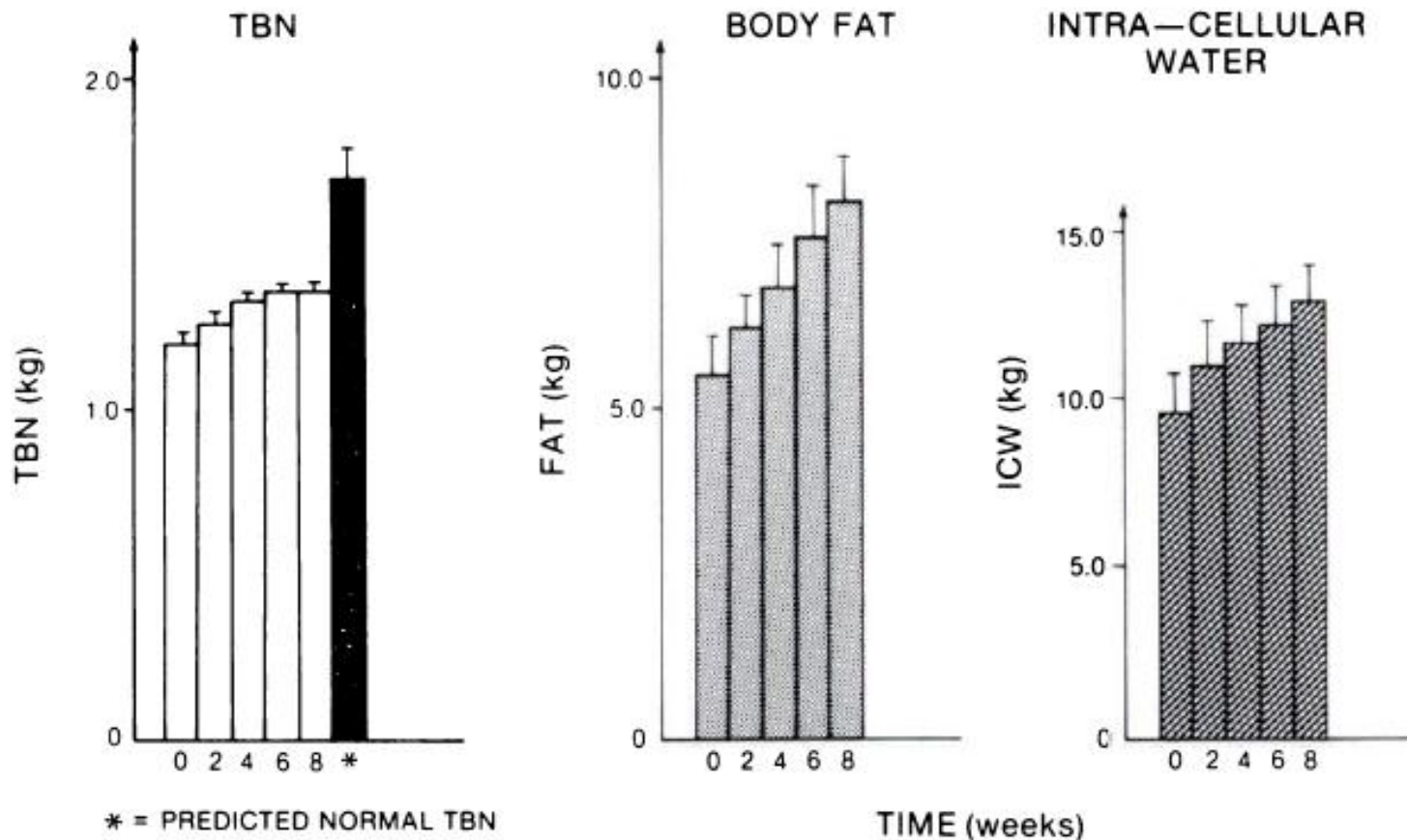


FIG 4. The *bar graphs* represent the mean \pm SEM values for body composition at baseline and 2, 4, 6, and 8 wk of refeeding. The predicted normal TBN is a calculated function of height.

Handgrip cont'd

- Commonly taken using the non-dominant arm, with the individual standing and the elbow of the arm extended.
- Can also be measured sitting or lying with the elbow of the arm in 90° flexion, or on the dominant arm.
- Different measuring positions are likely to give differing results (Hillman et al 2005). Therefore the testing position should be standardised, documented and consistently used for individuals or groups to ensure reliability and comparability.
- The preferred method for obtaining a maximum handgrip is to use the mean of three trials, but variations such as one trial, best of two or three have been investigated and have been found not be significantly different (Innes 1999)
 - Psychological well being and conditions such as rheumatoid arthritis may affect results and validity and should be considered
 - It is also possible that inflammation will affect muscle function therefore inflammatory markers & changes should also be considered



Southampton protocol for adult grip strength measurement. Roberts et al 2011

Handgrip: Reference ranges



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Gender/ age	Normal Mean (kg)	85% normal
Male		
18-69	40.0	34.0
70-79	32.5	27.5
80+	22.5	19.0
Female		
18-69	27.5	23.0
70-79	25.0	21.0
80+	20.0	17.0

Age Range	Left (kg) mean (95% CI)	Right (kg) mean (95% CI)
20-24	47.4 (38.8-56.1)	53.3 (45.2-61.5)
25-29	50.0 (41.1-58.9)	53.9 (44.3-63.6)
30-34	49.2 (40.4-57.9)	52.8 (44.1-61.5)
35-39	51.6 (44.0-59.3)	53.3 (44.0-62.6)
40-44	49.8 (42.5-57.1)	54.1 (47.1-61.2)
45-49	48.7 (40.3-57.2)	50.4 (42.5-58.3)
50-54	45.2 (39.4-51.1)	50.6 (44.2-56.9)
55-59	41.0 (33.7-48.4)	44.1 (36.7-51.4)
60-64	38.7 (33.4-44.0)	41.7 (36.8-46.7)
65-69	38.2 (32.0-44.4)	41.7 (35.4-47.9)
70-74	36.2 (30.3-42.1)	38.2 (32.0-44.5)
75+	29.8 (24.8-34.7)	28.0 (12.7-31.0)

Klidjian et al 1982 (cited in previous/
current nutritional assessment chapter
of PEN Handbook)

<85% of the standard mean value or
the lower limit of the 95% confidence
interval (CI) can serve as a
reasonable threshold for determining
impaired muscle function

Consolidated grip strength values for males (Bohannon et al 2006)-This and the corresponding female data are cited in new nutritional assessment chapter of PEN handbook

Centiles/reference ranges



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- **Comparison to ‘healthy population’ enables the extent and severity of over/under nutrition to be determined and cut offs can be established that allow individuals who are either malnourished or at risk to be identified.**
- **Population specific centiles should be used wherever possible and are considered more reliable.**
- **However in the majority of instances where longitudinal change is being monitored, it is more appropriate to use patients baseline results as their own reference.**
- **Until now Bishop et al (1981) centiles have been used, which are based on US NHANES data gathered between 1971-1974 on 13,671 free living individuals aged 18-74years.**
- **UK/Irish data limited and generally doesn’t cover all ages/genders**
 - Burr & Phillips (1984) 65-85years, based on 824 UK people can also be used
 - Corish & Kennedy (2003), based on 874 free living Irish individuals aged 65-92years can also be used.
- **Revised chapter now refers to updated US NHANES data (2008) gathered between 2003-2006 based on 19,593 free living individuals aged 20-80 years & over**
<http://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf>

Bioelectrical Impedance Analysis (BIA)



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- Use is increasing on both health & disease
- BIA measures TBW from which FM & FFM can be derived (based on the assumption that FFM is 73.2% water) but regression equations used to derive this information may not always be known/given
- Several different methods available eg
 - Single frequency, dual frequency, multi-frequency and spectroscopy and can provide information on whole body or segments depending on the machine used
- Single frequency BIA not considered appropriate in circumstances of abnormal tissue hydration.
- Regardless of the method a standard protocol should be used
 - Height, weight, standardisation of body position, previous exercise, dietary & fluid intake/output, skin temperature.

BIA- Phase angle (PA) as an outcome

- Low PA consistently been shown to have prognostic relevance in relation to morbidity & mortality (Wirth et al 2009)
- Variable derived from BIA, the PA reflects contributions between resistance and reactance
- Values typically range between 2 and 12°
- Biological meaning & pathogenic effects are not completely understood (Barbosa-Silva et al 2005)
 - Interpreted as an indicator of membrane integrity & water distribution between the Intra and extra cellular spaces
 - Also been used to predict BCM
- Also been shown to be associated with poorer outcomes, quality of life and function (Gupta et al 2004)

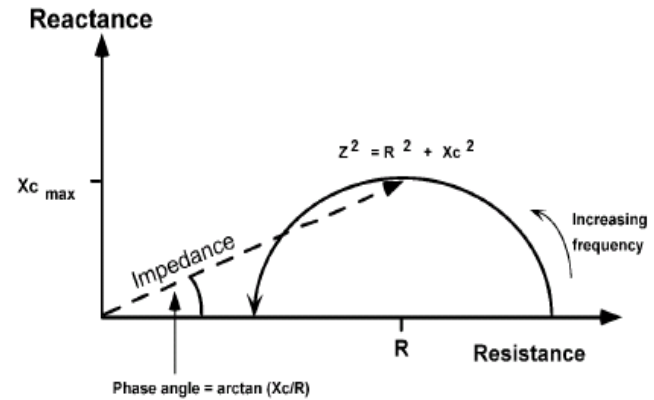


Fig. 1 Diagram of the graphical derivation of the phase angle; its relationship with resistance (R), reactance (X_c), impedance (Z), and the frequency of the applied current

Selberg 2002

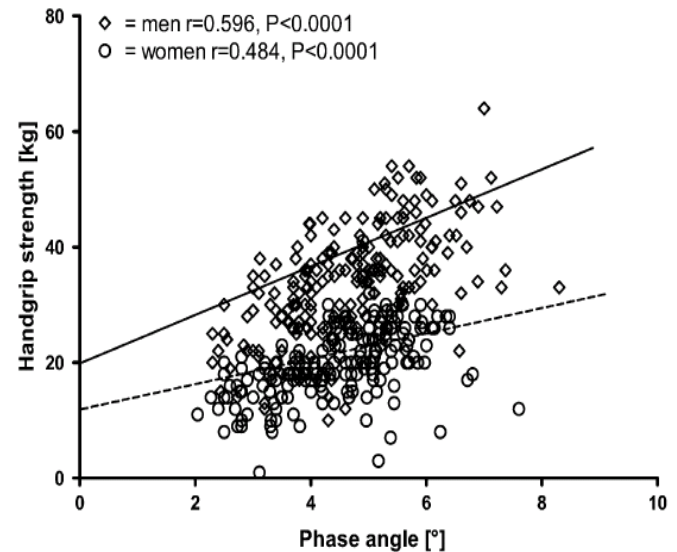


FIGURE 1. Pearson's correlation between phase angle and handgrip strength in men ($n = 208$, solid line) and women ($n = 191$, dotted line).

Gupta et al 2004

Conclusion



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- We need to, more than ever, focus on identifying and using valid, reliable and responsive outcome measures to demonstrate the effects of our daily interventions.
- There is currently an over reliance of Wt/BMI with changes in actual FM, FFM, function, QOL etc being largely neglected.
- There is also a need to extend our skills and expertise beyond what is now considered screening to demonstrate added value.
- Application of techniques and interpretation of results should be used with an awareness of what you are trying to quantify (FM v FFM v Function) and the possible limitations.
- Doing this allows us to refine/change our intervention/practice where appropriate to improve patient outcomes; to demonstrate clinical effectiveness and to demonstrate our added value as a Profession

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