Comparison of Air Displacement Plethymography and Dual Energy X-Ray Absorptiometry

Anaam Ali, Gerhard Fusch, Niels Rochow, Christoph Fusch

Division of Neonatology, McMaster University

Note: for non-commercial purposes only
Introduction

- Preterm infant survival has greatly increased over the last two decades, however infant morbidity rates remain high.

- Inadequate body composition during the postnatal period is associated with:
  - poor neurodevelopment
  - early onset of adult disease (DOHaD, Barker hypothesis)

- Absolute weight is primarily used to evaluate nutrition response, and to adjust nutrition.
  - lacks insight into growth of body compartments
Introduction

- Body composition is a more clinically relevant assessment of adequacy of nutrition
- Air displacement plethysmography (ADP) has been independently validated against established reference methods
- Little to no literature comparing ADP with DXA, particularly in the preterm population
Introduction

PEAPOD
- Uses displacement of air
- Measures
  - Body mass
  - Lean Mass
  - Fat Mass

DXA
- Attenuation of x-ray particle
- Measures
  - Body mass
  - Lean Mass
  - Fat Mass
  - Bone mineral content
Objective

- To compare body composition estimates from DXA and PeaPod in preterm infants <30 weeks of gestation
Methods

• Single centre observational study at McMaster Children’s Hospital

• n=72 preterm infants born <30 weeks of gestation

• Exclusion criteria:
  • Major congenital anomalies
  • Major chromosomal abnormalities
Methods

• 72 concurrent DXA (Hologic Discovery QDR 4500, Hologic Inc.) and ADP (PEA POD, COSMED) measurements were compared.

• Measurements at three time points: <36 weeks of corrected gestational age, term and 3 months corrected age (n=21, 33, and 18 respectively).

• Total mass measurements from DXA and PeaPod were compared against a third independent method, an electronic scale (Smart Scale® Model 65).
## Demographics

### Characteristics

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<tr>
<td><strong>n</strong></td>
<td>72</td>
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<tr>
<td><strong>Birth weight (g)</strong></td>
<td>988 ± 246 g</td>
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<tr>
<td><strong>Gestational age (weeks)</strong></td>
<td>27.1 ± 1.6 weeks</td>
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<td><strong>Sex (n, %)</strong></td>
<td>M 37 (51%)</td>
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<td>F 35 (49%)</td>
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Comparison of total mass from PeaPod and DXA. Measures are significantly correlated for total body mass ($R^2 = 0.997$)

Bland-Altman plot for PeaPod and DXA total mass. Mean difference is $228 \pm 84$ g ($p < 0.001$)
Comparison of fat mass from PeaPod and DXA. Measures are significantly correlated for absolute fat mass ($R^2 = 0.910$).

Bland-Altman plot for PeaPod and DXA fat mass. Mean difference is $-118 \pm 203$ g ($p < 0.001$).
Comparison of %fat mass from PeaPod and DXA. Measures are significantly correlated for % fat mass ($R^2 = 0.696$)

Bland-Altman plot for PeaPod and DXA %fat mass. Mean difference is $-4.4 \pm 4.4$ % ($p < 0.001$)
Comparison of body mass from DXA and PeaPod against an independent mass measure, Olympic Smart Scale. Measures are significantly correlated ($R^2 = 0.995$ and 0.999 respectively).

Bland-Altman plot for DXA and PeaPod mass against the Olympic Smart Scale. Mean difference is 231 ±115 g and 1.23 ± 58.9 g respectively) ($p<0.001$ for DXA, $p = 0.884$ for ADP)
High correlation of DXA with chemical analysis
Hologic 1500W – pencil beam

Similar results by Picaud (France), Koo (USA), Atkinson (Canada), Rigo (Belgium)

Fusch et al, Pediatr Res, 1999

\[ y = 1.0122x - 25.59 \]
\[ r = 0.999987 \]

\[ y = 0.7626x + 52.426 \]
\[ r = 0.9801 \]

\[ y = 0.6506x - 5.6584 \]
\[ R^2 = 0.9933 \]

\[ y = 0.9284x + 0.7715 \]
\[ r^2 = 0.984 \]

Gross energy [MJ] as measured by bomb calorimeter
Gross energy [MJ] as calculated from corrected DXA data
Discussion

• DXA and PeaPod estimates are highly correlated, but biased

• DXA has a systematic deviation from both the independent scale and the PeaPod scale

• DXA mass discrepancy is not explained by the mass of diapers or swaddling blankets (Koo, 1995)

• DXA calculates fat mass from radiation attenuation, and it is most likely the reason for underestimation of the fat mass
Discussion

- DXA measurement also has a large intra-device variability (Shypailo, 2013)

- Future studies need to identify the causes of the large inter-method bias
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