Rigshospitalet

GROWTH REPRODUCTION

Assessing abdominal fat distribution in 197 children using MRI as gold standard

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Background

Body mass index (BMI) (kg/m^2) is used to define overweight and obesity. However, BMI does not disclose the distribution of fat mass.

Increased abdominal adipose tissue, especially visceral abdominal adipose tissue, is associated with a higher risk of cardio-metabolic disease independent of BMI in adulthood. Hence the term "metabolically obese normal weight". As obesity in childhood tends to track into adulthood (1) so may body fat distribution. Precise measurements of abdominal adipose tissue in children may therefore enable early identification of "metabolically obese normal weight" children eligible for preventive initiatives and ultimately reduce the incidence of cardio-metabolic diseases in adulthood.

Aim

To validate estimation of abdominal adipose tissue by anthropometry and Dual X-ray Absorptiometry (DXA) using Magnetic Resonance Imaging (MRI) as gold standard.

Methods

A population-based cohort of 197 children (83 girls) aged 10-15 years. On the same day, a 3D thin slice abdominal MRI (L1-L4) (figure 1), a DXA with determination of regional fat percentages (figure 2) and a clinical examination with measurement of height, weight, waist circumference (WC) and skinfolds (biceps, triceps, subscapular and suprailiac) was performed (figure 3). Standard deviation scores (SDS) were calculated using Danish reference data (2,3) . Furthermore, pubertal development was assessed. Subcutaneous adipose tissue (SAT%) and visceral adipose tissue (VAT%) as a percentage of total abdominal volume was determined.

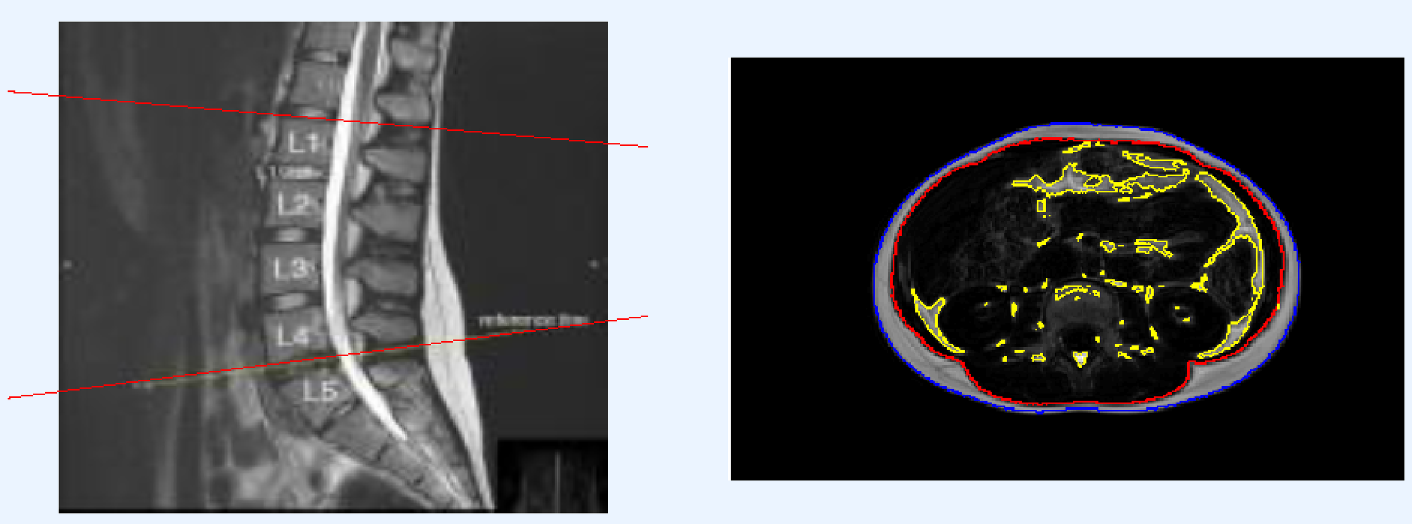

Figure 1

Left: MRI saggital section of the lumbar vertebral column. The red lines mark the boundaries of the abdominal 3D thin slice MRI (the upper edge of L1 to the lower edge of L4).
Right: MRI transverse section of the abdomen with segmentation of the subcutaneous adipose tissue (delineated by the blue and red lines) and visceral adipose tissue (delineated by the yellow lines).

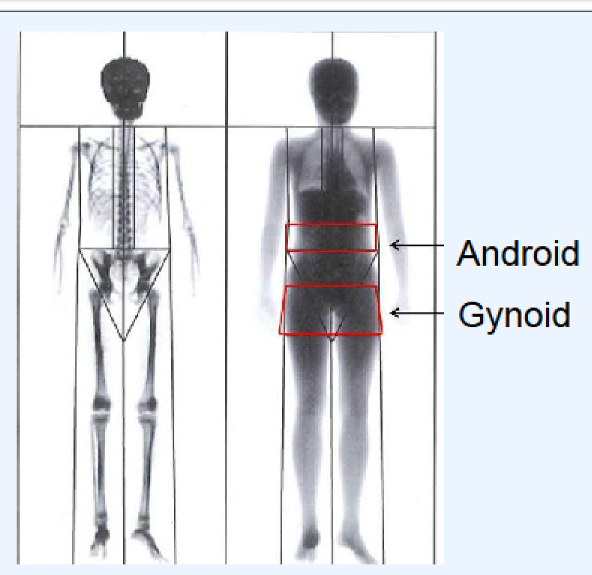

Figure 2

Whole body DXA scan. In red, the android and gynoid areas corresponding to the abdominal area and the hip area, respectively.

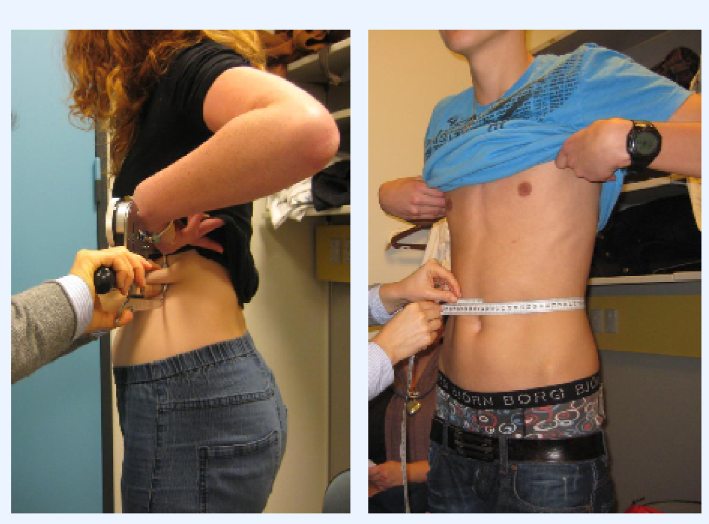

Figure 3

Left: Measurement of the suprailiac skinfold using a skinfold calliper .
Right: Measurement of the abdominal circumference.

Results

SAT% was significantly higher in girls compared to boys (median 17.9% vs. 12.8%, p<0.001, adjusted for puberty). VAT% was similar in girls and boys (median 6.7% vs. 6.5, p=0.654, adjusted for puberty).

DXA android fat%, suprailiac skinfold, BMI and WC (SDS) correlated strongly with SAT% (figure 4). In both genders, DXA android fat% was also correlated with VAT%. However, only in boys, anthropometric measurements were correlated with VAT% (figure 5).

In both genders, the best predictor of SAT% and VAT% was DXA android fat% explaining 81.5% and 81.2% of the variance in SAT% and 13.8% and 24.0% of the variance in VAT%, in girls and boys, respectively (all p<0.001). The second best predictor was suprailiac skinfold explaining 48.3% and 64.7% of the variance in SAT% (both p<0.001) and 7.1% and 15.9% of the variance in VAT% (both p<0.05), in girls and boys, respectively.

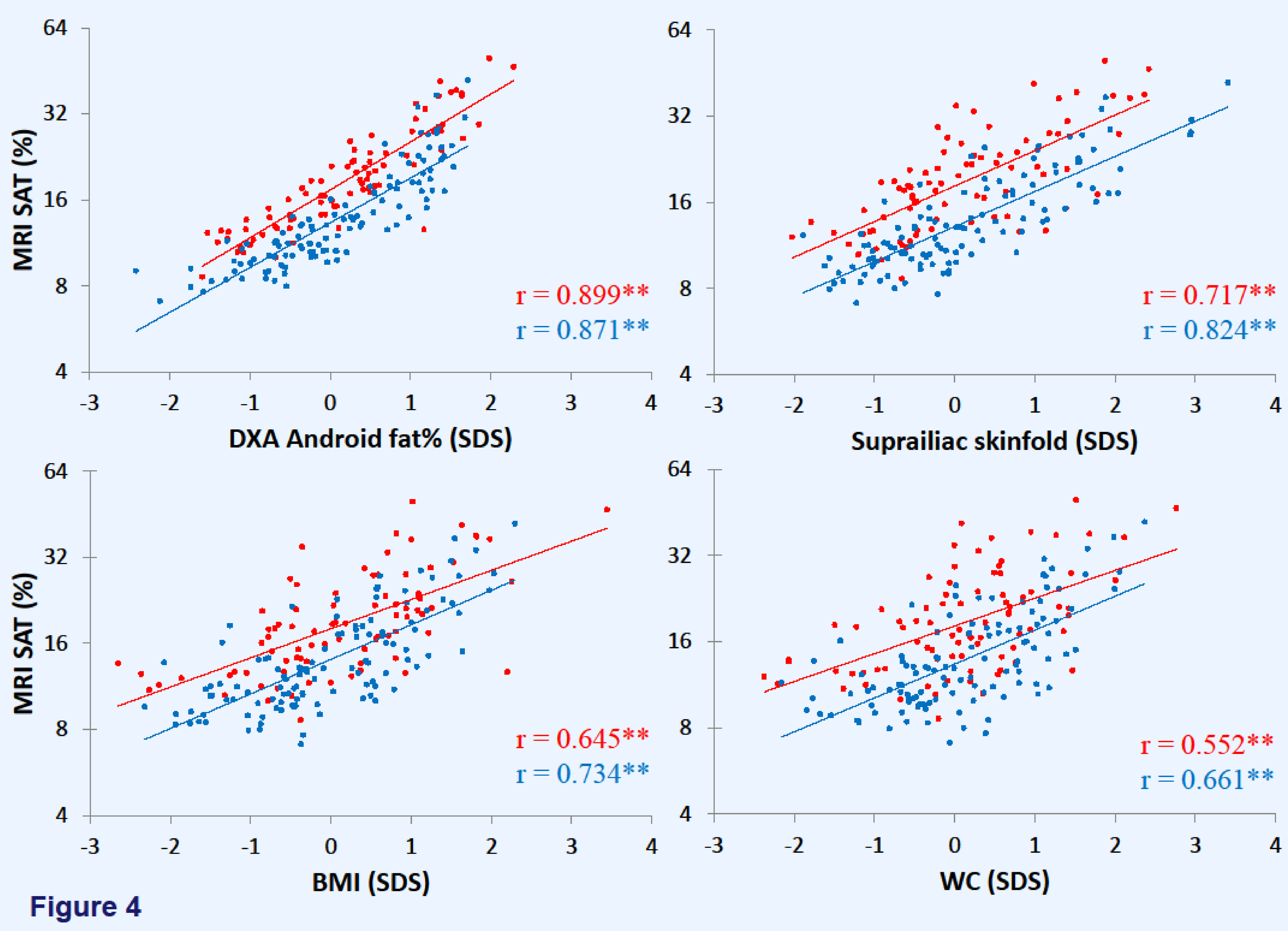

Figure 4

SAT% (log-scale) measured by MRI versus android fat% (SDS) measured by DXA, suprailliac skinfold (SDS), WC (SDS) and BMI (SDS). Girls are marked in red, boys in blue. Lines represent regression lines (r=Pearson's correlation coefficient).** p<0.001, *p<0.05.

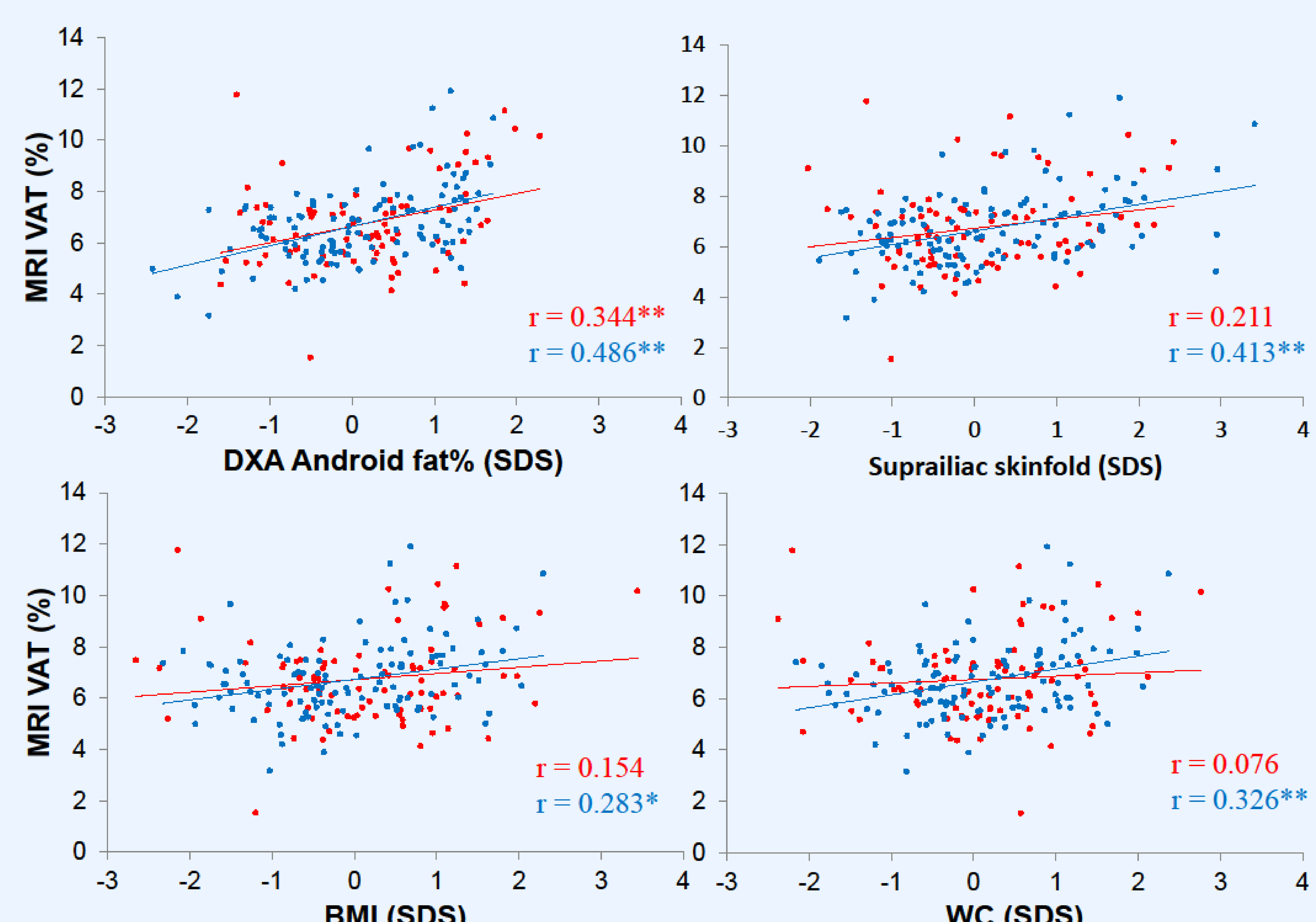

Figure 5

VAT% measured by MRI versus android fat% (SDS) measured by DXA, suprailliac skinfold (SDS), WC (SDS) and BMI (SDS). Girls are marked in red, boys in blue. Lines represent regression lines (r=Pearsons correlation coefficient).** p<0.001, *p<0.05.

Conclusions

In a population-based cohort of children aged 10-15 years

- DXA android fat%, suprailiac skinfold, BMI and WC are all good proxies for SAT% and may be used clinically
- However, prediction of VAT% using DXA or anthropometry is poor

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