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Independent effects of visceral, subcutaneous and liver fat, and fat-free mass on cardiometabolic risk factors in teenagers

A. Jones[1], J. Hauser[2], A. Karunakaran[2], K. Drechsler[3], A. Taylor[2], V. Muthurangu[2], R. Batterham[2]

[1]University of Oxford, Oxford, United Kingdom; [2]University College London, London, United Kingdom; [3]FH Aachen University of Applied Sciences, Aachen, Germany

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Cardiometabolic (CM) disorders begin earlier than previously thought. Better understanding of drivers of CM risk in the young is needed to address this. Adiposity is an established concern but studies largely rely on indirect markers eg. body mass index (BMI) to assess it. BMI is known to reflect both skeletal size & adiposity.

This study aimed to compare effects of BMI with independent effects of liver fat percentage (LFP), fat-free mass (FFM), & subcutaneous (SAT) & visceral (SAT) adipose tissue on CM risk in teenagers.

Healthy teens [N=82; Age 13–19y; 39 overwt/obese; 46F/36M] had volumetric magnetic resonance (MR) tissue mapping (neck-to-knee T2*-IDEAL). BMI z-score (WHO age/sex reference; zBMI), systolic BP (SBP), fasting blood (TRIGlyceride; CHOLesterol; HDL; IL6; CRP; white blood cells [WBC]; LEPTIN), & insulin & glucose response [0, 20, 40, 60, 90, 120 & 240 min] to a mixed meal (75g glucose + cream) were assessed. Indices of insulin resistance (HOMA-IR) and sensitivity (MATSUDA-IS) were derived from fasting measures & integrated meal responses, respectively. Independent effects of LFP, FFM, SAT & VAT were tested by conditional regression in a 4 compartment model (4CM).

Higher zBMI was positively correlated with TRIG, IL6, CRP, WBC, HOMA-IR, LEPTIN & SBP, & inversely with HDL & MATSUDA-IS (Table). The 4CM showed that SAT was responsible for most of these links but VAT contributed to lower MATSUDA-IS, SAT was positively correlated with CHOL (zBMI was not), & FFM was a significant predictor of HDL, CRP & LEPTIN. It was solely responsible for the association of zBMI with SBP. There were no independent effects of LFP. zBMI was strongly driven by both FFM & SAT, limiting its ability to differentiate effects of skeletal size from those of adiposity.

We found associations of zBMI with CM risk in teens that are usually interpreted as due to adiposity. Although SAT was largely responsible, FFM & VAT were important too & the link between BMI & SBP was due solely to FFM. Associations of CM risk factors with BMI may reflect non-adipose tissue effects & should be interpreted cautiously in the young.

Correlation coefficients

	BMI	TRIG (mmol/L)	CHOL (mmol/L)	HDL (mmol/L)	IL6 (pg/mL)	CRP (mg/L)	WBC (x10^9/L)	HOMA-IR	MATSUDA-IS	LEPTIN (ng/mL)	SBP (mmHg)
Median (IQR)	23.4 (20.3, 29.6)	0.64 (0.52, 1.00)	3.5 (3.2, 4.0)	1.2 (1.0, 1.3)	4.0 (2.6, 6.7)	0.67 (0.22, 1.80)	5.6 (4.7, 7.1)	1.5 (0.8, 2.2)	9.3 (5.5, 12.6)	11.1 (2.1, 24.6)	114 (108, 120)
zBMI		0.33§	0.16	–0.43‡	0.27¶	0.69‡	0.51‡	0.54‡	–0.48‡	0.77‡	0.27¶
LFP	0.18	–0.06	0.18	0.19	0.00	–0.06	0.11	0.23	–0.21	–0.00	0.13
VAT	0.07	0.18	0.08	–0.22	0.09	–0.00	0.12	0.19	–0.35§	–0.08	0.09
SAT	0.89‡	0.37§	0.33§	–0.25¶	0.37§	0.57‡	0.45†	0.61‡	–0.44†	0.85‡	–0.10
FFM	0.86‡	0.04	–0.16	–0.34§	–0.02	0.31¶	–0.01	0.25	–0.25	0.39§	0.34§

¶P<0.05; §P<0.01; †P<0.001; ‡P<0.0001.