Abdominal adiposity and total body fat as predictors of cardiometabolic health in pre-pubertal and pubertal youth

Binghan Jin[1], Hu Lin[1], Jinna Yuan[1], Guanping Dong[1], José G B Derraik[1,2,3,4*], JunFen Fu[1*]

1.Endocrinology Department, Children's Hospital of Zhejiang University School of Medicine, Hangzhou, China; 2.Liggins Institute, University of Auckland, Auckland, New Zealand; 3.A Better Start National Science Challenge, University of Auckland, New Zealand; 4.Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden.

Prof Junfen fu (fjf68@qq.com) , Dr José Derraik (j.derraik@auckland.ac.nz)

Aim

To investigate the usefulness of abdominal adiposity and total body fat as predictors of cardiometabolic health, especially insulin sensitivity, in children and adolescents.

Methods

Participants:

- **479 children and adolescents aged 3-18 years with obesity (BMI ≥ 95th percentile) attending the Children's Hospital at Zhejiang University School of Medicine.**

Clinical assessments:

- **Anthropometry, sexual maturation, clinic BP, OGTT, dual-energy x-ray absorptiometry (DXA) scan, carotid artery ultrasound, lipid profile, liver function.**

Data analyses:

- **Participants were stratified into groups by sex and pubertal status.**
- **Associations between total body fat percentage (TBF%) and android fat to gynoid fat ratio (A/G, a marker of abdominal adiposity) were compared to clinical outcomes using multiple linear regressions and generalized linear regression models.**

Results

- **A/G was a better predictor of metabolic anormalities than TBF%, particularly among pubertal boys (Table 1).**
- **For every 0.1 increase in A/G was associated with a 44% and 42% increase in the risk of impaired glucose tolerance in purbetal boys and girls (Table 1).**
- **A/G was more strongly associated with cardiometabolic outcomes than TBF% across the three groups (Tables 2A-C).**
- **A/G was shown to be a strong linear predictor of parameters of glucose metabolism (Tables 2A-C), particularly in pre-pubertal boys (Table 2A).**
- **Notably, TBF% was not associated with any cardiometabolic outcomes among pubertal girls, in stark contrast to A/G (Table 2C).**
- **Blood pressure was the only measured outcome that was not found to be associated with either A/G or TBF% in any of the three groups examined.**

Conclusions

- **Among Chinese children and adolescents with obesity, A/G was a stronger predictor of metabolic abnormalities in pre-pubertal and pubertal children in comparison to TBF%.**
- **Thus, the distribution of adipose tissue in children and adolescents (particularly abdominal adiposity) is a better predictor of metabolic health than overall body fat.**

Table 1. The adjusted relative risk (aRR) of adverse cardiometabolic outcomes in association with A/G and TBF% among pre-pubertal boys (A; n=139), pubertal boys (B; n=183), and pubertal girls (C; n=140) with obesity in Hangzhou (China).

[1] Models included the A/G and TBF% as independent variables.
[2] Models included the A/G, TBF%, and testicular volume as independent variables.
[3] Models included the A/G, TBF%, and age as independent variables;
[4] aRR are shown in association with a change of 0.1 in the A/G.
*p<0.05; **p<0.01; NAFLD, non-alcoholic fatty liver disease.

		Pre-pubertal boys [1]		Pubertal boys [2]		Pubertal girls [3]	
		Prev.	aRR (95% CI)	Prev.	aRR (95% CI)	Prev.	aRR (95% CI)
Impaired glucose tolerance	A/G [4]	15.1%	1.33 (0.82, 2.13)	18.2%	**1.44 (1.08, 1.92)***	18.6%	**1.42 (1.05, 1.93)***
	TBF %		1.05 (0.91, 1.22)		1.03 (0.94, 1.12)		0.96 (0.88, 1.05)
Abnormal glycaemia	A/G [4]	35.3%	1.05 (0.78, 1.40)	39.8%	**1.24 (1.02, 1.52)***	40.7%	1.20 (1.00, 1.44)
	TBF %		1.01 (0.93, 1.10)		1.00 (0.95, 1.05)		0.97 (0.92, 1.03)
NAFLD	A/G [4]	61.2%	**1.19 (1.07, 1.33)***	59.1%	**1.19 (1.06, 1.34)****	49.3%	1.09 (0.92, 1.29)
	TBF %		1.05 (0.99, 1.11)		**1.05 (1.02, 1.08)****		1.02 (0.96, 1.09)
Hyperuricaemia	A/G [4]	8.6%	1.20 (0.62, 2.32)	24.4%	1.18 (0.96, 1.44)	12.1%	**1.77 (1.08, 2.91)***
	TBF %		1.02 (0.82, 1.25)		1.03 (0.96, 1.10)		0.94 (0.81, 1.08)

Table 2. Linear associations between A/G, TBF%, and cardiometabolic parameters among pre-pubertal boys (A; n=139), pubertal boys (B; n=183), and pubertal girls (C; n=140) with obesity in Hangzhou (China).

† Parameters were log-transformed to approximate a normal distribution.
‡ β coefficients are shown in association with a change of 0.1 in the A/G ratio.
Std β = standardised β coefficients. *p<0.05; **p<0.01; ***p<0.001; and ****p<0.0001.

A) Pre-pubertal boys

		A/G ‡		TBF%	
		β (95% CI) *	Std β	β (95% CI) *	Std β
Glucose metabolism	Matsuda index †	**-0.34 (-0.45, -0.22)****	**-0.45**	-0.03 (-0.06, 0.01)	-0.11
	Fasting glucose (mmol/l)	0.00 (-0.08, 0.09)	0.00	0.01 (-0.02, 0.04)	0.07
	Fasting insulin (μIU/ml)	**4.68 (2.79, 6.57)****	**0.38**	0.52 (-0.08, 1.12)	0.14
	HbA1c (%)	**0.12 (0.01, 0.24)***	**0.17**	0.01 (-0.03, 0.05)	0.05
	C-peptide peak (mmol/l)	**0.72 (0.27, 1.16)****	**0.30**	0.13 (-0.01, 0.26)	0.18
Liver function	ALT (U/l) †	**0.23 (0.05, 0.39)****	**0.24**	0.00 (-0.05, 0.06)	0.01
	AST (U/l) †	0.07 (-0.05, 0.18)	0.10	0.01 (-0.02, 0.05)	0.06
Inflammatory markers	Uric acid (μmol/l)	**29.8 (13.0, 44.6)****	**0.29**	**5.7 (0.7, 10.7)***	**0.18**

B) Pubertal boys

		A/G ‡		TBF%	
		β (95% CI) *	Std β	β (95% CI) *	Std β
Glucose metabolism	Matsuda index †	**-0.15 (-0.23, -0.06)*****	**-0.25**	-0.01 (-0.03, 0.01)	-0.08
	Fasting glucose (mmol/l)	0.03 (-0.04, 0.09)	0.06	0.00 (-0.02, 0.01)	-0.01
	Fasting insulin (μIU/ml)	**2.11 (0.18, 4.03)***	**0.16**	**0.51 (0.06, 0.97)***	**0.18**
	HbA1c (%)	0.06 (-0.03, 0.16)	0.10	0.00 (-0.02, 0.02)	-0.01
	C-peptide peak (mmol/l)	**0.47 (0.15, 0.78)****	**0.24**	0.04 (-0.04, 0.11)	0.09
Liver function	ALT (U/l) †	**0.17 (0.05, 0.28)****	**0.22**	**0.03 (0.01, 0.06)***	**0.18**
	AST (U/l) †	0.06 (-0.01, 0.13)	0.12	0.01 (0.00, 0.03)	0.12
Lipid profile	Total cholesterol (mmol/l)	0.00 (-0.15, 0.15)	-0.001	-0.01 (-0.04, 0.03)	-0.03
	Triglycerides (mmol/l) †	-0.03 (-0.10-0.03)	-0.07	**-0.03 (-0.04, -0.01)****	**-0.26**
	LDL (mmol/l)	-0.01 (-0.11, 0.09)	-0.02	0.01 (-0.01, 0.03)	0.07
	HDL (mmol/l)	-0.01 (-0.05, 0.03)	-0.03	0.00 (-0.01, 0.01)	0.02
Inflammatory markers	Uric acid (μmol/l)	**22.0 (7.5, 36.5)****	**0.21**	1.2 (-2.25, 4.65)	0.05
Atherosclerosis marker	CIMT (mm)	0.04 (-0.13, 0.21)	0.04	**0.04 (0.01, 0.08)***	**0.19**

C) Pubertal girls

		A/G ‡		TBF%	
		β (95% CI)	Std β	β (95% CI)	Std β
Glucose metabolism	Matsuda index †	**-0.18 (-0.28, -0.07)****	**-0.31**	0.01 (-0.03, 0.04)	0.08
	Fasting glucose (mmol/l)	0.06 (-0.03, 0.14)	0.14	-0.01 (-0.03, 0.01)	-0.09
	Fasting insulin (μIU/ml)	**3.44 (1.09, 5.79)****	**0.28**	-0.10 (-0.71, 0.52)	-0.03
	HbA1c (%)	0.04 (-0.06, 0.15)	0.09	0.00 (-0.03, 0.02)	-0.03
	C-peptide peak (mmol/l)	0.33 (-0.04, 0.70)	0.21	0.02 (-0.08, 0.11)	0.03
Liver function	ALT (U/l) †	**0.27 (0.15, 0.38)*****	**0.41**	-0.02 (-0.05, 0.01)	-0.12
	AST (U/l) †	**0.16 (0.07, 0.24)*****	**0.38**	-0.01 (-0.03, 0.01)	-0.11
Lipid profile	Total cholesterol (mmol/l)	**0.20 (0.04, 0.37)***	**0.25**	-0.01 (-0.05, 0.03)	-0.05
	Triglycerides (mmol/l) †	0.05 (-0.02, 0.13)	0.14	0.00 (-0.02, 0.02)	-0.04
	LDL (mmol/l)	**0.15 (0.03, 0.26)***	**0.27**	-0.01 (-0.04, 0.02)	-0.05
	HDL (mmol/l)	-0.03 (-0.07, 0.02)	-0.12	0.01 (-0.01, 0.02)	0.11
Inflammatory marker	Uric acid (μmol/l)	**27.2 (12.9, 41.55)*****	**0.36**	-3.6 (-7.3, 0.1)	-0.17

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Binghan Jin

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