Propensity for Visceral and Hepatic Adiposity Varies Among Ethnic Groups of Healthy Children

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Background.

- Ethnic differences in fat distribution may account for the heterogeneity of between obesity and disease risk including diabetes and breast cancer.
- Hispanic and Asian adults have been reported to have higher ectopic fat stores than Whites while Black adults have less. The ethnic differences in ectopic fats in children is less studied.
- We compared visceral (VAT), and percent liver fat (pLF) in five ethnic groups of healthy children recruited into a multi-center cross-sectional study.

Methods.

- Participants from the Shape Up! Kids study (1) receive a variety of tests including dual-energy X-ray Absorptiometry (DXA), MRI scans, anthropometry, blood sample, and health questionnaire. (Figure 1)
- Recruitment was stratified by sex (M/F), age (5 to 17 years), race [White (W), Asian (A), Black (B), NHOPI, Hispanic (H)], and BMIZ. DXA VAT was represented as cross-sectional area (cm2).
- A multi-region average was used for MRI PLF. Ethnic difference for the ectopic fat subgroups were described by sex and adjusted for age and total body fat.

Results.

- Out of 302 children, 222 had valid DXA and MRI scans. (Table 1)
- No VAT differences were observed for boys or girls after adjustment for total fat.
- The strongest predictor of liver fat was body mass index (BMI; p < 0.0001);overweight and obesity were associated with 0.5% and 1% higher liver fat levels. (Table 2)
- The respective adjusted mean percent values were 2.9 (95% CI 2.7, 3.1) and 3.4(95% CI 3.2, 3.6) as compared to normal weight (2.4; 95% CI 2.3, 2.6). See Figure 2.
- Percent liver fat was highest in Whites and African Americans, intermediate in Hispanic, and lowest among Asians and Native Hawaiians/Pacific Islanders. Age, sex, physical activity, and diet quality were not significantly related with liver fat. (Table 3 and Figure 3)

Conclusion.

- There exists a strong relationship of BMI with percent liver fat even in children with low liver fat levels without detecting an association with age, sex, and dietary or physical activity patterns.
- After adjusting for total body fat, no differences in VAT by ethnicity were observed.

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White healthy children had the highest liver fat and Asian children the lowest with strong associations to BMI
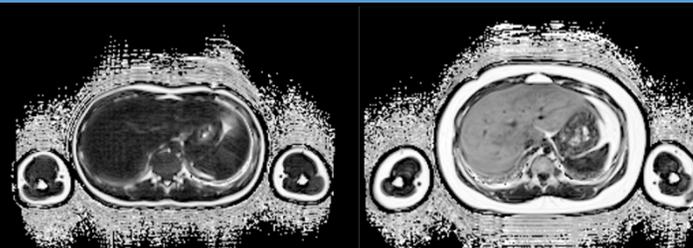

Figure 1. Example MRI images of the liver. (left) 12 year old male, normal BMI-Z, 19% Fat, 1.8% Liver Fat, (Right) 11 year old male, Overweight BMI-Z, 31% Fat, 22.6% Liver Fat.
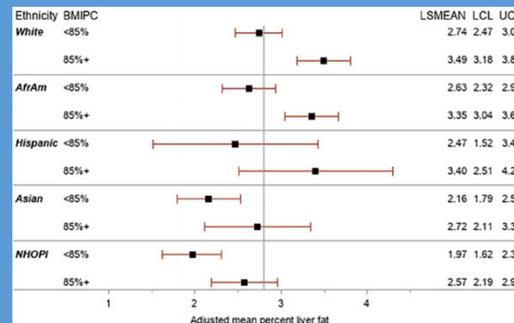

Figure 2. Adjusted mean percent liver fat by ethnicity and weight status. overall mean = 2.8.*
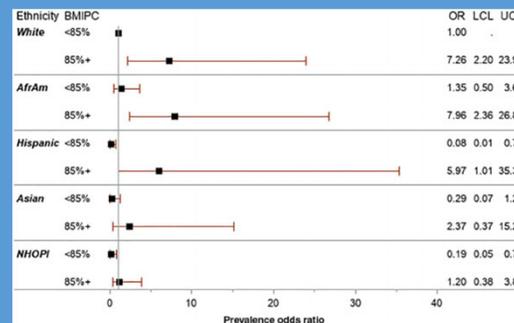

Figure 3. Prevalence odds ration (POR) for high liver fat (>= 2.68%) by ethnicity and weight status.*

* Lower (LCL) and upper (UCL) 95% confidence limits obtained by general linear regression adjusted for age, sex, physical activity, and diet quality and stratified by body mass index percentile (BMIPC); overall mean = 2.8, NHOPI, Native Hawaiian//Other Pacific Islander

Table 1. Characteristics of participants in the Shape Up! Kids Study

Characteristic	Category	Girls	Boys	All
N (%)		123 (55)	99 (45)	222 (100)
Age, yrs		12.3 ± 3.4	12.1 ± 3.1	12.2 ± 3.2
Ethnicity (%)	White	34 (28)	38 (39)	72 (32)
	African American	37 (30)	25 (25)	62 (28)
	Hispanic	14 (11)	8 (8)	22 (10)
	Asian	14 (11)	10 (10)	24 (11)
	NHOPI[b]	24 (20)	18 (18)	42 (19)
Tanner stage (%)[c]	1	32 (28)	33 (35)	65 (31)
	2	13 (12)	14 (15)	27 (13)
	3	20 (18)	13 (14)	33 (16)
	4	22 (20)	23 (24)	45 (22)
	5	25 (22)	11 (12)	36 (18)
BMI (%)	Normal weight	62 (50)	64 (65)	126 (57)
	Overweight	27 (22)	17 (17)	44 (20)
	Obesity	34 (28)	18 (18)	52 (23)
Weight, kg		51.9 ± 20.7	50.5 ± 19.9	51.3 ± 20.3
Height, cm		149.3 ± 15.7	152.7 ± 19.0	150.8 ± 17.3
Waist circumference, cm		77.7 ± 16.7	73.3 ± 14.0	75.7 ± 15.5
BMI-for-age percentile, %		72 ± 29	64 ± 29	69 ± 29
DXA total body fat, kg		17.1 ± 10.3	11.8 ± 7.6	14.7 ± 9.6
DXA % total body fat, %		31.1 ± 7.4	22.8 ± 9.0	27.4 ± 9.1
DXA visceral fat area, kg		38.0 ± 27.7	42.3 ± 17.0	39.9 ± 23.6
MRI liver fat, %		2.8 ± 0.9	2.8 ± 0.9	2.8 ± 0.9
Physical activity score[c]		2.6 ± 0.7	3.0 ± 0.7	2.8 ± 0.7
Fruits/veggies (%)	<10/week	73 (59)	56 (57)	129 (58)
	10+/week	50 (41)	43 (43)	93 (42)
Sweets & sugared drinks (%)	<4/week	56 (46)	50 (51)	106 (48)
	4+/week	67 (54)	49 (49)	116 (52)
Diet quality (%)	High SS, Low FV	47 (38)	26 (26)	73 (33)
	Low SS, Low FV	26 (21)	30 (31)	56 (25)
	High SS, High FV	20 (16)	23 (23)	43 (19)
	Low SS, High FV	30 (25)	20 (20)	50 (23)

[a]Means ± standard deviations are shown unless otherwise indicated, [b]NHOPI=Native Hawaiian/Other Pacific Islander, [c]Missing values for Tanner stage (N=16) and physical activity score (N=60)

Table 2. Relation of adiposity measures with levels of liver fat in the Shape Up! Kids Study

Characteristic	Girls		Boys	
	ρ[a]	P-value	ρ[a]	P-value
Weight, kg	0.308	0.001	0.224	0.026
Height, m	0.003	0.977	-0.037	0.714
Waist circumference, cm	0.286	0.001	0.288	0.004
BMI-for-age percentile, %	0.506	<0.0001	0.431	<0.0001
DXA total body fat, kg	0.367	<0.0001	0.348	0.0004
DXA % total body fat	0.457	<0.0001	0.358	0.0003
DXA visceral fat, kg	0.381	<0.0001	0.380	0.0001

[a]Spearman correlation coefficients are shown

Table 3. Determinants of liver fat in the Shape Up! Kids Study.

Model	Characteristic	Category	β	Std Error	P-value
1: BMI (r²=0.36)	Age	Years	-0.008	0.019	0.67
	Sex (Ref=Girls)		0.111	0.102	0.28
	BMI (Ref=Normal weight)	Overweight	0.461	0.130	0.0005
		Obesity	0.967	0.126	<0.0001
	Ethnicity (Ref=White)	African American	0.017	0.131	0.90
		Hispanic	-0.142	0.183	0.44
		Asian	-0.460	0.178	0.01
		NHOPI[b]	-0.766	0.143	<0.0001
	Diet quality[c] (Ref=High SS, Low FV)	Low SS, Low FV	0.003	0.135	0.98
		High SS, High FV	0.156	0.146	0.29
		Low SS, High FV	0.016	0.138	0.91
	Physical activity (Ref=Low[d])	High	-0.041	0.125	0.74
2: DXA % body fat (r²=0.30)	Age	Years	-0.009	0.020	0.66
	Sex (Ref=Girls)		0.306	0.119	0.01
	DXA percent body fat	%	0.039	0.007	<0.0001
	Ethnicity (Ref=White)	African American	0.026	0.137	0.85
		Hispanic	-0.181	0.192	0.35
		Asian	-0.511	0.186	0.007
		NHOPI[b]	-0.699	0.151	<0.0001
	Diet quality[c] (Ref=High SS, Low FV)	Low SS, Low FV	0.110	0.139	0.43
		High SS, High FV	0.166	0.153	0.28
		Low SS, High FV	0.053	0.145	0.72
	Physical activity (Ref=Low[d])	High	0.113	0.133	0.40

References

1. Wong MC, Ng BK, Kennedy SF, et al. Children and Adolescents' Anthropometrics Body Composition from 3-D Optical Surface Scans. Obesity (Silver Spring) 2019; 27: 1738-1749.