

Interethnic differences in fat metabolism of overweight Chinese, Malays and Indians by MRI and MRS approaches

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Introduction. The study of fat distribution is important to understand the pathophysiology of obesity-related disorders, diabetes mellitus and cardiovascular diseases. Excessive accumulation of fat in liver, muscle and abdomen are known to reduce insulin sensitivity [1-3]. Several studies have also suggested that the fat distribution is different across different ethnic groups [2-3]. In this study, we determined the relationship between insulin sensitivity and abdominal, hepatic and intramyocellular fat (IMCL) accumulation. We also examined whether there are ethnic differences in these fat depots in a multi-ethnic cohort of overweight adults.

Methods. The study population consisted of 17 Chinese, 26 Malay and 26 Indian males (age 21 to 40 years) with BMI ranging from 25 to 30 Kg/m². Anthropometric measurements and the metabolic profiles were obtained from all subjects. Insulin sensitivity index (ISI) was determined using hyperinsulinemic euglycemic glucose clamp. The percentage body fat was measured by dual-energy X-ray absorptiometry (DEXA). We determined IMCL and hepatic fat using ¹H MRS and abdominal fat using MRI on a 3T MR scanner (Tim Trio, Siemens). The spectra from the liver (Figure 1) and soleus muscle (Figure 2) were obtained using PRESS sequence, TE/TR = 30/2000ms and processed using LCModel [4]. The liver fat was determined from the concentration of methyl, methylene groups and unsuppressed water signal [5] and muscle fat is expressed as a ratio of IMCL to Creatine (Cr). The abdominal fat images were acquired using two-point Dixon sequence. We employed a graph theoretic segmentation algorithm based on [6] to separate and quantify the subcutaneous (SAT) and visceral adipose tissues (VAT) between L1-L5 lumbar vertebrae [7], see Figure 3.

Results. Insulin sensitivity was lowest in Indians (4.03 mg/kg/s/ μ U/mL \times 10⁻²) and highest in Chinese (5.58 mg/kg/s/ μ U/mL \times 10⁻²). Indians had the highest levels of total and subcutaneous abdominal fat, IMCL and liver fat, see Figure 4. Chinese had the lowest IMCL and subcutaneous abdominal fat, while Malays showed the lowest hepatic fat. The age was not significantly different among the three ethnic groups. Overall, the fat volumes had significant inverse correlation with ISI (all p values < 0.0001), see Table 1. One way ANOVA showed significant ethnic differences in IMCL, SAT and % body fat, see Table 2. No differences were observed for visceral fat and liver fat between the ethnic groups.

Conclusion. To the best of our knowledge, this is the first study comparing the interethnic differences of fat depots within the Asian population including Chinese, Malay and Indian subjects. IMCL, abdominal and hepatic fat were significantly correlated with ISI. IMCL and subcutaneous fat showed significant differences among the ethnic groups while hepatic fat and visceral fat had no differences.

References. [1] Xiaojuan et al. MRI 2008; 26:188-197. [2] Liska et al. PLoS ONE 2007; 2:e569 [3] Marshall et al. Obesity Research 2004; 12(8):1352-1359. [4] Provencher MRM 1993; 30:672-679. [5] Cowin et al. JMRI 2008; 28:937-945. [6] Suresh et al. NeuroImage 2010; 49:225-239. [7] Parimal et al. ISMRM 2009.

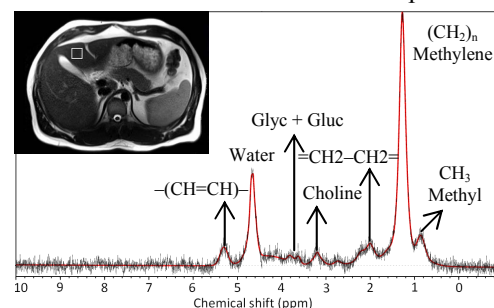


Figure 1. Liver spectrum

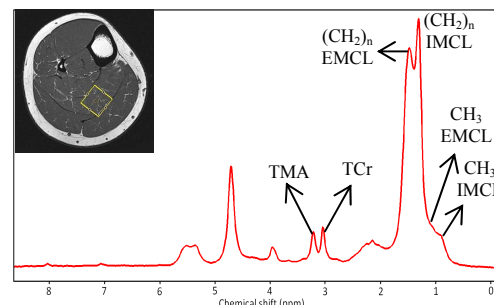


Figure 2. Spectrum of soleus muscle

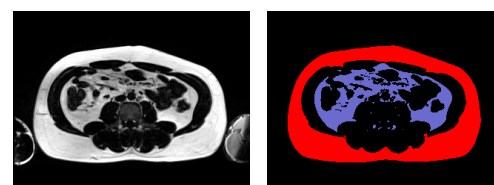


Figure 3. Separation of SAT (red) and VAT (blue)

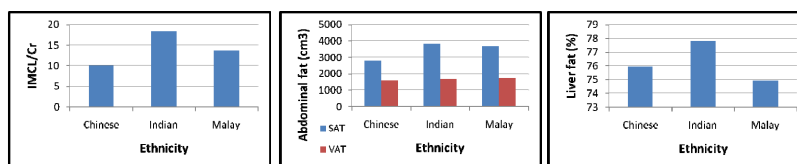


Figure 4. Mean IMCL, hepatic fat, SAT and VAT of the three ethnic groups

Table 1. Correlation coefficients of fat depots with insulin sensitivity

IMCL	-0.14
SAT	-0.44
VAT	-0.62
Liver fat	-0.40
%Body fat	-0.63

Table 2. p-values of ANOVA showing differences across ethnic groups

IMCL	0.0002
SAT	0.0064
VAT	0.7104
Liver fat	0.5121
%Body fat	0.0140
ISI	0.0763