Interethnic differences in abdominal fat (deep, superficial and visceral) accumulation

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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. Several studies have suggested that the fat distribution is different across different ethnic groups [1,2]. In this study, we investigated the relationship between the abdominal fat depots, visceral adipose tissue (VAT), deep (DSAT) and superficial (SSAT) adipose tissues and BMI in Chinese, Malays and Indians living in Singapore.

Methods. The study consisted of 268 healthy male adults (101 Chinese, 82 Malays and 85 Indians), aged 21 to 40 years with BMI 18 to 30 kg/m^2. Anthropometric measurements and metabolic profiles were obtained from all subjects. The abdominal fat images were acquired using two-point DIXON sequence (TR=5.28 ms, TE1=2.45 ms, TE2=3.68 ms, FA=9 deg, 80 axial slices) on a 3T MR scanner (Tim Trio, Siemens). We employed a fully automated graph theoretic segmentation algorithm [3] to separate the subcutaneous (SAT) and visceral adipose tissues (VAT) between L1-L5 lumbar vertebrae. Further, the SAT was classified into DSAT and SSAT using distance regularized level set evolution (DRLSE) [4], which is a new variant of level set without re-initialization. The energy function is defined as $\varepsilon(\phi) = \mu R_p(\phi) + \varepsilon_{ext}(\phi)$, where $R_p(\phi)$ is the distance regularization term, $\varepsilon_{ext}(\phi)$ is the external energy depending on edge-based image information.

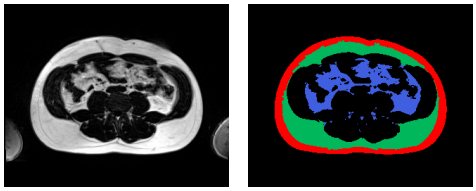

Fig 1. Separation of SSAT (red), DSAT (green) and VAT (blue)

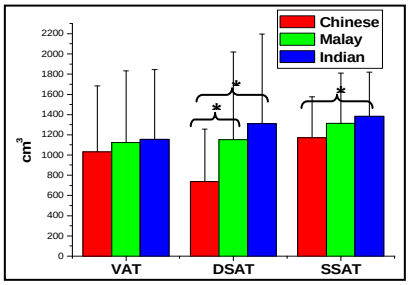

Fig 2. Ethnic differences in abdominal fat distribution (*p<0.01)

Results. DSAT and SSAT showed statistically significant differences between the ethnic groups. Indians had greatest adiposity in all three compartments (SSAT, DSAT and VAT) followed by Malays and Chinese. The greatest differences between ethnic groups were observed for DSAT, see Figure 2. These differences did not reach statistical significance for VAT. All the fat depots showed strong correlations with BMI. DSAT (C/M/I: r = 0.80, r = 0.87, r = 0.75, all p<0.005) and SSAT (C/M/I: r = 0.84, r = 0.90, r = 0.86, all p<0.01) were strongly associated with BMI than VAT (C/M/I: r = 0.57, r = 0.70, r = 0.69, all p<0.001) in all the ethnic groups. With the increase in BMI, Chinese accumulated significantly (p<0.01) less DSAT than Malays and Indians. The accumulation of more SSAT and VAT with increasing BMI was similar in all three ethnic groups. The increase in the ratio of DSAT to SAT and the decrease in the ratio of SSAT to SAT with increasing obesity were significantly higher (p<0.01) in Malays compared to Indians and Chinese.

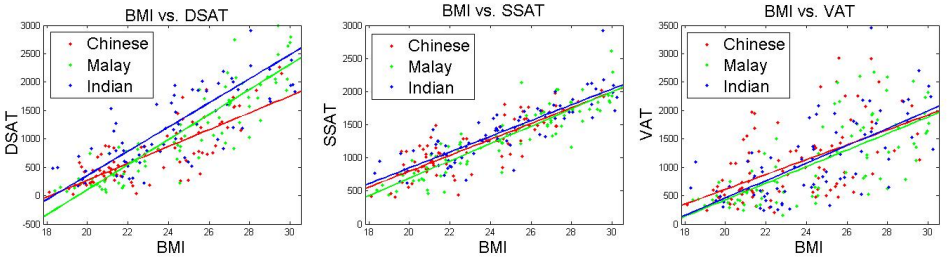

Fig 3. Relationship between DSAT, SSAT, VAT and BMI among the three ethnic groups

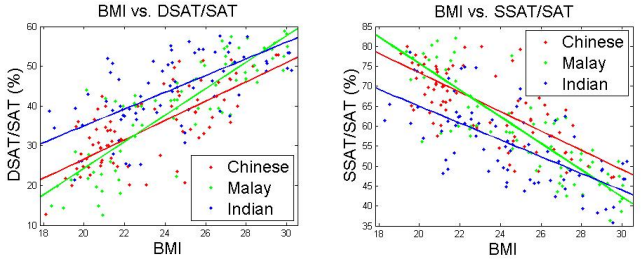

Fig 4. Relationship between BMI and fat depots

Conclusion. Different ethnic groups exhibit differences in adiposity, particularly in DSAT. With increasing levels of obesity, Chinese accumulated less DSAT than Malays and Indians. The physiological significance of these differences remains unclear and need be further investigated.

References. [1] Liska et al. PLoS ONE 2007; 2:e569 [2] Marshall et al. Obesity Research 2004; 12(8):1352-1359. [3] Vitali et al. Intl. Patent WO/2011/139232,2011. [4] Li et al. IEEE Trans. Image Process. 2010; 19(12):3243-3254.