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Increasing Weight Loss Attenuates the Preferential Loss of Visceral versus Subcutaneous Fat:

a Predicted Result of an Allometric Model

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Chaston and Dixon recently published an excellent systematic review analyzing the factors contributing to the relative change of visceral versus subcutaneous abdominal fat during weight loss (1). Their principle finding was that there is no compelling evidence that any investigated weight loss intervention selectively targets the reduction of visceral adipose tissue (VAT) to a greater extent than another. This conclusion agrees with our recent findings that changes of VAT mass are allometrically related to changes of total body fat mass (FM) during weight loss, regardless of gender or weight loss intervention (2). However, we were intrigued by another of their conclusions: that VAT was lost preferentially versus subcutaneous adipose tissue (SAT) with modest weight loss, but the effect was attenuated with greater weight loss (1). Here we show that our simple allometric model also predicts this result.

By expressing FM change as the sum of the changes of VAT and SAT masses, our allometric model can be rewritten as follows:

$$\frac{dVAT}{VAT}=k\frac{dFM}{FM}$$
$$\frac{dVAT}{VAT}=k\left(\frac{dVAT}{FM}+\frac{dSAT}{FM}\right)$$
$$dVAT\left(\frac{1}{VAT}-\frac{k}{FM}\right)=\frac{k}{FM}dSAT$$
$$\frac{dVAT}{dSAT}=\frac{k}{FM/VAT-k}$$
$$\frac{\%\delta V}{\%\delta S}=\frac{SAT_0}{VAT_0}\left(\frac{k}{FM/VAT-k}\right)$$

where ($\%\delta V/\%\delta S$) is the percentage change in VAT versus SAT which was the primary variable calculated by Chaston and Dixon to measure preferential loss of VAT (1). The allometric constant is $k = 1.3 \pm 0.1$ (2) and SAT_0 and VAT_0 are the initial values of SAT and VAT, respectively. Using the fact that the allometric equation can be integrated exactly to give: $VAT = b\times FM^k$ (2), where b is a positive constant determined by the initial values of VAT and FM, we derived the following equation for how preferential VAT loss changes with FM:

$$\frac{d}{dFM}\left(\frac{\%\delta V}{\%\delta S}\right)=\frac{(k-1)k}{b}\frac{SAT_0}{VAT_0}\left(\frac{1}{FM^{1-k}/b-k}\right)^2 FM^{-k}$$

Since all factors on the right hand side of the above equation are positive, this equation implies that the preferential loss of VAT decreases with decreasing total body fat as would be expected with increased weight loss.

A direct quantitative comparison with the results of Chaston and Dixon is complicated by the fact that FM was not reported and the SAT measurements were restricted to the abdomen and possibly limited to a single MRI or CT slice (1). Nevertheless, consider the following numerical example assuming that an obese subject with FM_0 = 40 kg and VAT_0 = 7 kg loses 20% of their body weight corresponding to a FM loss of about 15 kg. The above equations predict that ln ($\%\delta V/\ \%\delta S$) will start at about 0.3, decrease at an initial rate of 0.01 units per kg FM loss, and will drop by roughly 0.15 units with a 20% weight loss. These calculated values have the same order of magnitude as the results of Chaston and Dixon (1). Therefore, we suggest that future investigations should use the allometric model predictions as a null hypothesis to test for an additional independent effect of weight loss. In conclusion, our simple allometric model predicts that increasing weight loss attenuates the preferential loss of VAT versus SAT. Nevertheless, it should be emphasized that greater weight loss will cause a greater absolute reduction of VAT mass and may thereby result in improved metabolic health (2,3).

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