



## Lean-scaled weight: a proposed weight scalar to calculate drug doses for obese patients

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### To the Editor,

Lean body weight (LBW) is a weight-related quantity that is useful when calculating drug doses for obese patients.<sup>1</sup> The LBW cannot be used directly as a weight scalar because it results in underestimation of doses when they are calculated as milligrams per kilogram.<sup>2</sup> Following is a description of a proposed weight scalar that is proportional to the LBW and normalized for both obese and non-obese patients.

Recommended drug doses are often expressed per kilogram of body weight. Total body weight (TBW) is the appropriate weight scalar for use with patients of normal weight; however, both drug distribution and clearance are altered in obesity, and using a milligram per kilogram dose based on TBW may result in drug overdose for morbidly obese patients.<sup>3</sup>

Lean body weight is TBW minus the fat mass and, for practical purposes, represents fat-free mass. It correlates with cardiac output and drug clearance and is arguably the single best weight scalar for use in morbidly obese patients<sup>1</sup>—although the volume of distribution for lipophilic drugs may be more dependent on TBW or fat mass.<sup>3</sup> Dosages of fentanyl, sufentanil, and remifentanil, as well as induction doses of propofol and thiopental, scale consistent with LBW in obese patients.<sup>4</sup> Janmahasatian *et al.* have developed a semi-mechanistic model to predict LBW that has been validated with dual-energy *x-ray* absorptiometry

and bioelectrical impedance analysis.<sup>5</sup> Their model calculates LBW as a function of TBW and body mass index (BMI) with coefficients that differ between men and women.

Since LBW is what remains after fat mass is subtracted from TBW, it is always less than TBW, non-obese patients included. For this reason, LBW cannot be used directly to calculate drug doses on a milligram per kilogram basis and must be scaled upwards to avoid underdosing. Bouillon and Shafer published a nomogram to accomplish this, but the scale did not extend beyond a BMI of about 40 because of limitations of the then available equations for calculating LBW.<sup>2</sup> To normalize LBW in a predictive pharmacokinetic model for propofol, McLeay *et al.* used the Janmahasatian LBW calculations and increased all doses by a factor chosen to result in the recommended dose for a male patient with a BMI of 21.6. This model successfully predicted the plasma propofol concentrations.<sup>6</sup>

The weight scalar proposed here, i.e., the lean-scaled weight (LSW), is obtained by multiplying the Janmahasatian LBW functions by a scale factor such that the LSW calculated for a patient with a BMI of 22 is equal to that patient's TBW. The LSW is always proportional to the LBW, and it is normalized to scale correctly for all weights and heights. The factors for the male and female functions are 1.2332 and 1.5262, respectively, and are implicit in the following formulas:

For men:  $LSW = 11,432 \times TBW / (6,680 + 216 \times BMI)$

For women:  $LSW = 14,148 \times TBW / (8,780 + 244 \times BMI)$

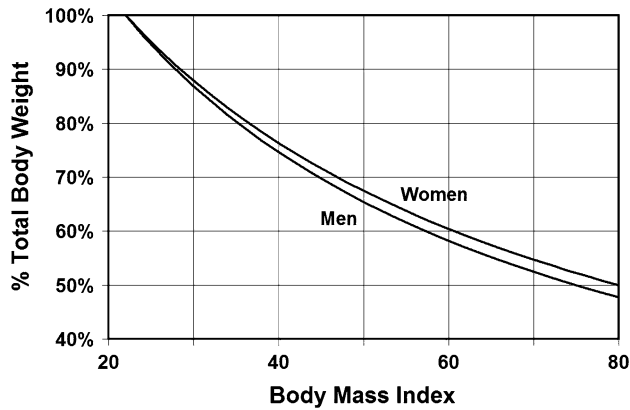
The [Figure](#) shows the LSW as a percentage of the TBW. At BMI values of 40, 60, and 80, the LSW/TBW ratios are roughly 75%, 60%, and 50%, allowing for easy estimation of appropriate doses in the operating room. For example, a

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The author has written a (non-commercial) computer program that calculates the lean-scaled weight and other obesity-related parameters. A few phrases in this Letter to the Editor have wording similar to text in this program.

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**Figure** The lean-scaled weight (LSW) is plotted as a percentage of the total body weight (TBW) against the body mass index (BMI). The appropriate modification of dosage for obesity can be read directly from the graph. A patient with a BMI of 22 will be given 100% of the dose calculated using the TBW. For a patient weighing 100 kg with a BMI of 40, the LSW is about 75% of the TBW; therefore, when programming a pump for a remifentanyl infusion, it is reasonable to enter a weight of 75 kg. A cross-platform app for calculating the LSW (and other obesity-related parameters) is available from the author by E-mail

woman weighing 160 kg with a height of 164 cm would have a BMI of about 60, and it would be reasonable to use a weight of 96 kg when calculating her induction dose of

propofol. The LSW is proposed as a useful weight scalar for use with those drugs whose dosages scale consistent with LBW.

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**Conflicts of interest** None declared.

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