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Don't assume cause and effect is obvious: Why obesity isn't to blame for errors in burn assessment

For several years, the medical community has been concerned that evaluations of burns are becoming less accurate. This is a problem because burns leak, and burn victims must receive supplemental fluids to compensate for the loss. If too little fluid is supplied, the victim suffers from dehydration and potentially life-threatening consequences. Similarly, over-hydration brings other, equally unpleasant problems.

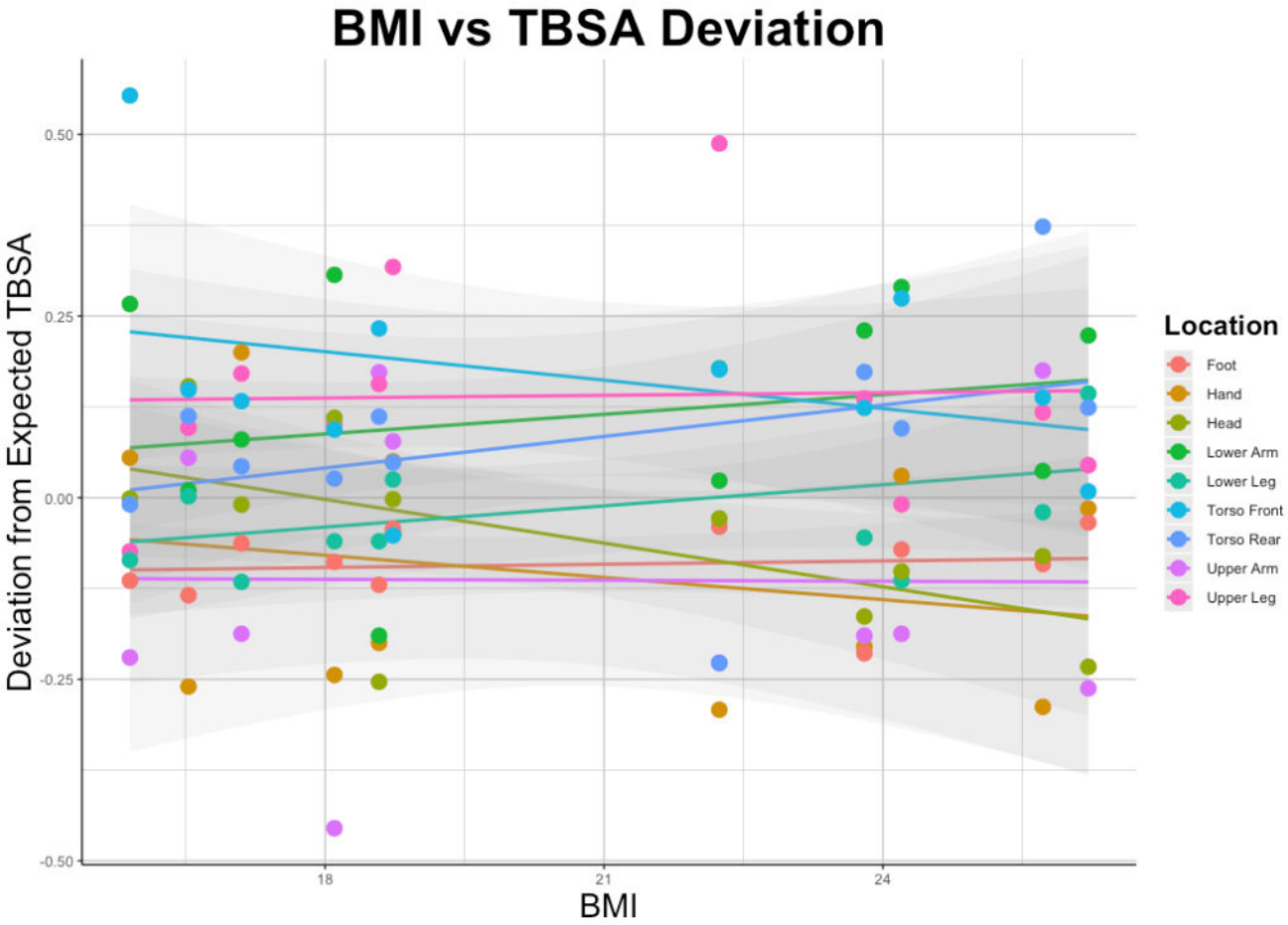

Fig. 1. The chart shows the difference between the measured %area and predicted %area for each of 9 body regions based on the Lund and Browder chart, versus Body Mass Index (a common measure of obesity) for 11 pediatric subjects. Regardless of which body region we look at, there is no significant correlation between BMI, and %area deviations in the size of that body region compared to the size predicted by the Lund and Browder chart. The correlation coefficient (R-squared) for even the most suggestive-looking trend-line (the torso rear) is only .46, and its P-value, uncorrected for multiple hypotheses is only .02. Moreover, even if the possible trends are real, they only account for a few %TBSA, and this few %TBSA is both much smaller than the non-obesity-related individual-to-individual variation, and, completely inadequate to account for the up to 50 %TBSA errors seen in actual burn cases.

The rate of fluid loss is correlated to the size of the burn, so the required rate of supplemental hydration is also correlated. Therefore, first-responders, who supply initial fluid doses, need accurate tools for estimating the size of burns. A few percent error in the accuracy of a percent of Total Body Surface Area (%TBSA) estimate is typically not a problem. Unfortunately, burn centers are increasingly receiving burn victims who have, e.g. estimates of, and therefore first-responder-supplied fluid replacement appropriate for 70 %TBSA burns while only having 30 %TBSA actual burned surface, and vice versa. Errors this large can cost financial waste, extra surgeries, and even patient death.

The increasing error-prone estimates being seen recently have raised suspicion that the primary tool – a sub-divided chart of regional body area percentages called the Lund and Browder chart (L&B) – is losing accuracy as the population becomes increasingly obese. The L&B chart was developed from average body sizes in the 1940s, when the world's population was relatively thin due to World War II rationing. The increasing errors in %TBSA estimates correlates with the "obesity epidemic". Anecdotally-reported error rates are increasing since the early 1990s.

The obvious answer, and, for over 25 years, obvious response, has been repeated attempts to adjust the L&B chart to match the body metrics of the increasingly obese population. Unfortunately, these attempts have produced little, if any benefit in decreasing the error rate or magnitude in %TBSA estimates. Critically, all of these attempts tried to improve the chart based on the assumption that errors originated in the values in the chart, and not elsewhere. As a result, they did not base their adjustments on any gold-standard measurement of bodies, but rather only on a belief that "the chart must be adjusted to match the numbers".

To increase insight into the errors, we collected and analyzed a set of full-body 3D scans of pediatric subjects at the low and high extremes of the obesity curve. This is the first time such a data set has been collected, and we assumed that by choosing individuals with the widest range of body types, we could accurately measure how badly the L&B chart needed to be adjusted.

Our results surprised us. There is no significant correlation between obesity and divergence from the L&B chart-predicted %TBSA values. The L&B chart is just as accurate for extremely obese and extremely thin people. Moreover, the L&B chart is acceptably accurate (well within 10%) on even the worst outliers.

The obvious answer is apparently wrong. For over 25 years, burn treatment has been getting worse, rather than better, because the correlation between obesity and errors in %TBSA estimates was so obvious that no-one thought to look for other answers. Additional research reveals that the probable real source of increasing errors is simple math. Interestingly, there is another change that correlates with the obesity epidemic – the increased acceptance of calculators in math classes at the elementary and high school level. It is not a stretch to imagine that students always trained to used calculators for simple addition, have increased difficulty doing simple addition in their heads in stressful situations. This is only an "obvious" correlation however, and we're not jumping to conclusions this time until we have conclusive proof.

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Publication

Comparison of the Lund and Browder table to computed tomography scan three-dimensional surface area measurement for a pediatric cohort.

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