

# The Body Composition Gold Standard: Hologic's approach to calibration for body composition measurements using DXA

*Thomas L. Kelly, Senior Principal Scientist  
Hologic, Inc., Marlborough, MA*

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## Background

DXA is considered the gold standard method for measuring body composition for both practical and technical reasons including widespread availability, ease of use, low dose, accuracy, precision, and segmental 3-compartment analysis.<sup>1</sup> Hologic® first released high speed, wide-angle body composition capabilities on our QDR-4500™ DXA system in 1995. Since then, we have continually worked to improve the analysis algorithm, calibration, user interface, and reports. In 1997, Hologic was chosen as the exclusive DXA system for the U.S. Center for Disease Control's National Health and Nutrition Examination Survey (NHANES). Several other large, NIH-funded research studies, including the Health, Aging, and Body Composition (Health ABC) study, also selected Hologic instruments. In 2011, Hologic released the Advanced Body Composition® assessment with InnerCore™ Visceral Fat assessment software. Today, Hologic continues to innovate in the field of body composition to maintain our leadership position as the gold standard measurement system for clinical medicine, research, and athletic applications.

## Classic Calibration

Hologic offers two different body composition calibration settings in our software: Classic calibration and NHANES calibration. Classic calibration is currently the default calibration setting for new DXA systems and is based on primary standards of stearic acid and water. Stearic acid is a common mammalian fat that is widely available in solid form and therefore makes a good DXA calibration standard for fat. On a lean and fat scale from 0% to 100%, stearic acid was defined as 100% fat. The choice of a lean standard is more complicated because lean mass is composed of water, skeletal muscle, proteins, trace minerals, and electrolytes. After some deliberation, water with

physiologic amounts of electrolytes (8.6%) was chosen as the lean standard and used to represent human tissue comprised of 0% fat.<sup>2</sup> Using stearic acid and saline as the two primary calibration standards, Hologic created a proprietary calibration algorithm making minor adjustments to reflect lean mass hydration assumptions, and performed correlation studies to other gold standard body composition measurements available including underwater weighing.<sup>3</sup> An additional proprietary process is completed in manufacturing to ensure that each Hologic DXA system is calibrated to the highest possible accuracy and shipped with a unique serialized phantom. This phantom and the internal Dynamic Calibration™ system ensure exceptional short- and long-term precision as well as the most accurate 3-compartment analysis of body composition available today.<sup>4,5</sup>

## NHANES Calibration

Hologic released the NHANES calibration as the default setting in APEX Version 2.0 based on research studies comparing DXA results in the NHANES pilot study to other body composition measurement systems, principally deuterium dilution and hydrostatic weighing.<sup>6</sup> At the recommendation of the group conducting the NHANES pilot study, the NHANES calibration setting was adopted which reduces lean mass by a factor of 0.946, resulting in an increased body fat percentage of 3-5% in human subjects. The "NHANES BCA" adjustment to the Classic calibration was implemented via a multiplicative reduction in lean mass as recommended by Schoeller et al., with the practical implication that leaner subjects (individuals with more lean mass) will see a greater increase in % body fat than subjects with less lean mass.

In 2020, Hologic returned the default setting to Classic calibration based on newly available information comparing both Classic calibration and NHANES calibration to the Lohman 4C model.<sup>7</sup> Ng et al. demonstrated a high agreement in % body fat calculation between Hologic DXA Classic calibration and the Lohman 4C model. Figure 1 demonstrates the high agreement between the Classic calibration setting and relatively poor agreement of the NHANES calibration setting versus the criterion method. Other studies by Smith-Ryan et al.<sup>8</sup> have also demonstrated improved accuracy when utilizing the Classic calibration setting. Most experts and clinicians now agree that the Classic calibration setting provides the most accurate body composition results.

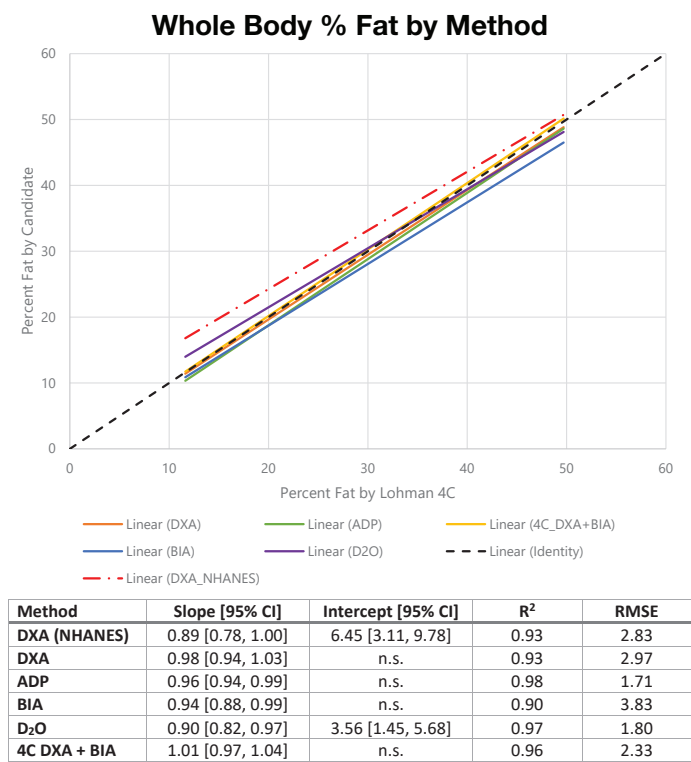


Figure 1. Whole body percent fat from various body composition methods versus the reference 4C Lohman model. “n.s” indicates that the regression intercept was non-significant and set to zero. It can be seen that DXA\_NHANES (Hologic DXA with NHANES calibration setting enabled) significantly overestimates percent fat versus all other methods tested, particularly in leaner individuals. This figure was republished with permission from the authors from Supplemental Figure 1 from Ng et al. Validation of rapid 4-compartment body composition assessment with the use of dual-energy X-ray absorptiometry and bioelectrical impedance analysis. *Am J Clin Nutr* 2018; 108:708-715.

### What it means for users

Currently, both calibration settings are available to the user as shown in Figure 2 and each user is encouraged to determine which calibration setting is appropriate for their needs. If a user is currently completing body composition studies and upgrading a previous Hologic DXA system, they may wish to continue using the same calibration setting on their current system for follow-up scans. This is because with a change in calibration, the user will see a change in % body fat results and it is important to maintain the same calibration setting between follow-up scans. For new studies the Classic calibration is preferred.

It should be noted that when the user changes calibration settings, the setting is applied to both new body composition scans as well as the reference database. The calibration setting does NOT impact the calculation of diagnostic scores and percentiles. Reference databases for both settings are implemented in the software and keyed to the calibration setting (Classic or NHANES), and this process is completely transparent to the end user. In practice, all users still have access to the NHANES reference database values that includes over 20,000 individual observations regardless of calibration setting.<sup>9</sup>

In the example shown in Figure 3, the Age Matched percentile of any given individual is the same regardless of which calibration setting is chosen. The subject remains in the 11th percentile for % body fat with both calibration settings; however, their measurement of % body fat is 16.7% with the Classic calibration setting and 21.0% with the NHANES calibration setting.

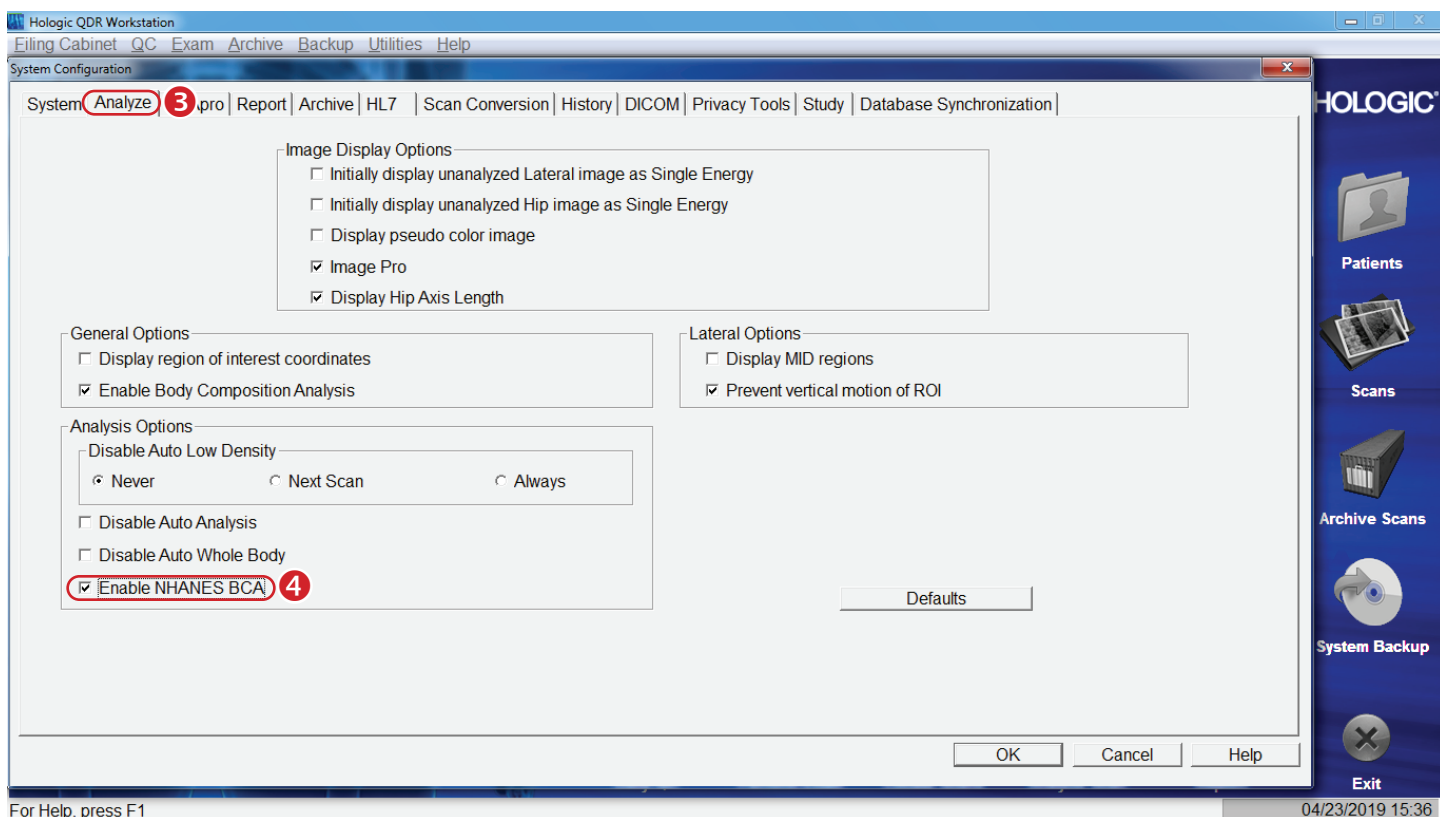
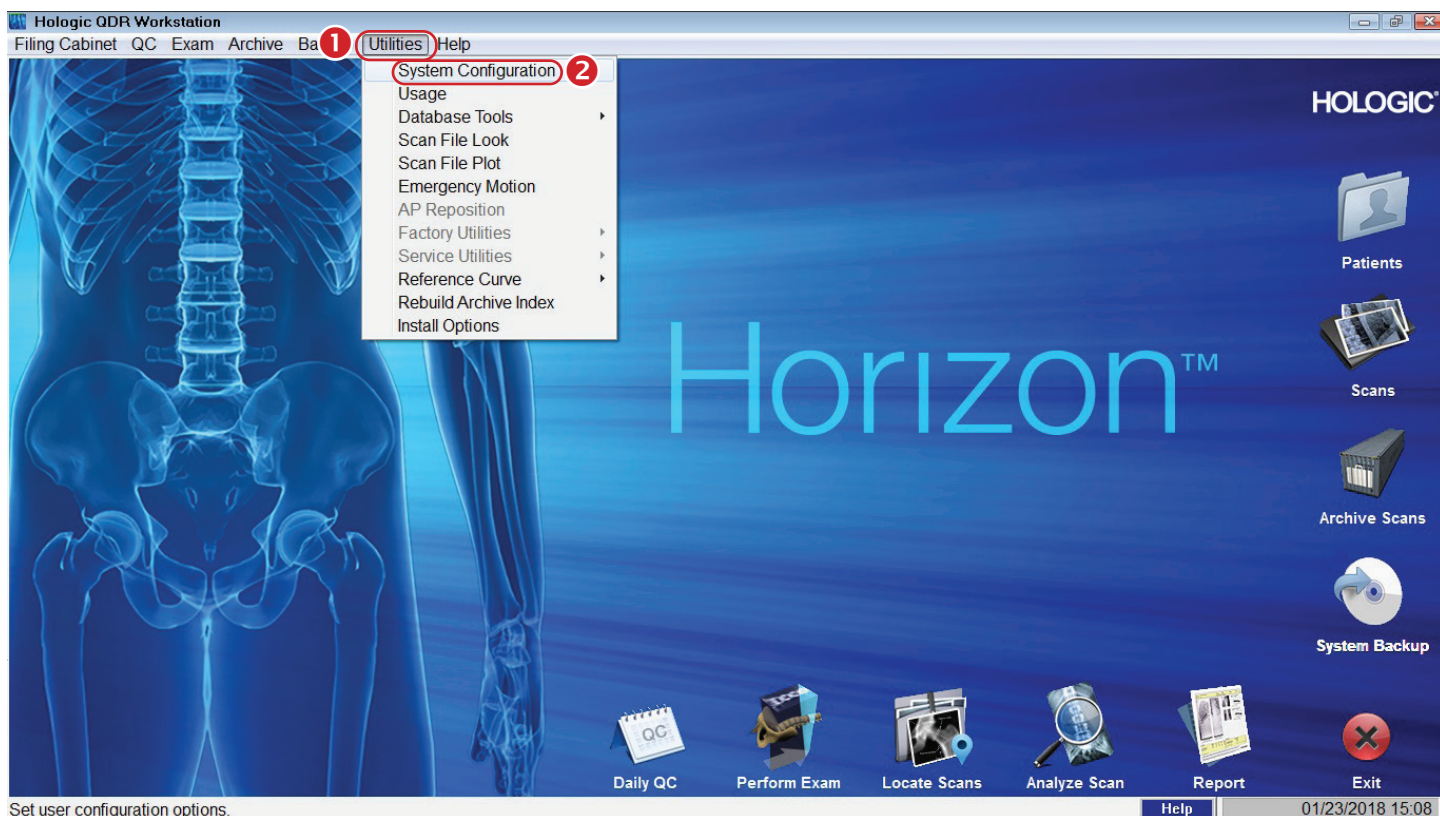
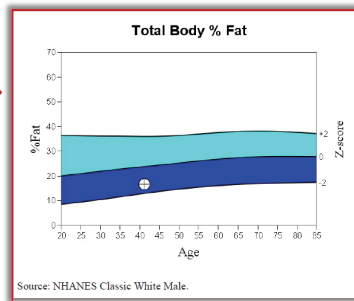
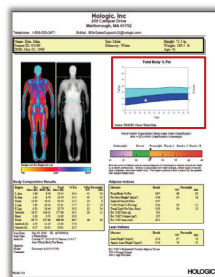


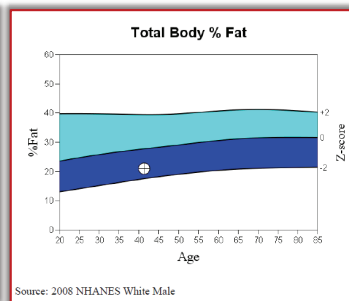
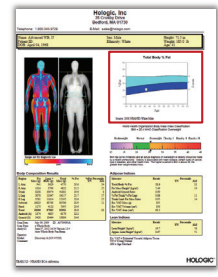
Figure 2. From the APEX™ software home screen, select Utilities ① > System Configuration ② > Analyze ③. If the “Enable NHANES BCA” ④ option is checked, the NHANES calibration setting is selected. If the “Enable NHANES BCA” option is unchecked, the Classic calibration setting is selected.

## Classic Calibration



Total Body Fat: 16.7%  
AM Percentile: 11

## NHANES Calibration



Total Body Fat: 21.0%  
AM Percentile: 11

Figure 3. (L) Horizon DXA results for individual with the Classic calibration setting. (R) Horizon DXA results for the same individual with the NHANES calibration setting. Note the difference in Total Body % Fat.

## Conclusion

The field of body composition is a dynamic and changing landscape as experts continue to enhance the clinical performance of body composition analysis and results. DXA continues to represent the gold standard measurement system for body composition in clinical medicine, research, and athletic applications. Continued development and enhancement by Hologic scientists and engineers will keep Hologic DXA body composition applications on the forefront for years to come.

## References

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## United States / Latin America

250 Campus Drive  
Marlborough, MA 01752 USA  
[hologic.com](http://hologic.com)  
[BSHSalesSupportUS@hologic.com](mailto:BSHSalesSupportUS@hologic.com)  
Tel: +1.508.263.2471

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