TECHNICAL NOTE
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EVALUATION OF A COMMERCIAL NEAR-INFRARED INSTRUMENT FOR BODY COMPOSITION ANALYSIS

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INTRODUCTION

The potential use of Near-IR interactance for determining body composition was first investigated by Conway, Norris, and Bodwell[1] in a study funded by the U.S. Department of Agriculture. Their study used a computer-controlled research spectrophotometer to correlate Near-IR interactance (NIR) measurements with hydrostatic weighing and skinfold thicknesses.

Recently, a moderately priced Near-IR instrument was introduced: the FUTREX-5000™ (Manufacturer: Futrex, Inc., Gaithersburg, Maryland). This instrument uses interactance technology similar to that of Conway et al. The Human Performance Center (HPC), Alexandria, Virginia has performed a preliminary evaluation of the FUTREX-5000™. This initial evaluation included more than eighty subjects, covering a wide range of percent fat levels, gender and racial origins

At the Human Performance Center, each subject's body composition was determined by 1) hydrostatic (densiometric) weighing technique following the protocols as described by Katch[2], determination of residual volume as described by Goldman and Buskirk[3] and calculation of percent body fat through the formula developed by Siri[4] 2) by multiple site skinfold measurements following the protocol

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[1] Conway, J.M., K. Norris, C.E. Bodwell, "A New Approach for the Estimation of Body Composition: Infrared Interactance", the *American Journal of Clinical Nutrition*, 40, December, 1984.

[2] Katch, A.S. *et al*. Estimation of body volume by underwater weighing: description of a simple method. *Journal of Applied Physiology*. 23-811,2. 1967.

[3] Goldman, R.F., and E.R. Buskirk. Body volume measurements by underwater weighing: Description of a method, in Brozek, J. and A. Henschel A. (eds): *Techniques for Measuring Body Composition*. Washington, D.C., National Academy of Science, 1961.

[4] Siri, W. E., *Body composition from fluid spaces and density*. University of California Report, Donner Laboratory of Medical Physics, 1978.

of Jackson and Pollock[5] 3) by anthropometric measurements as developed by Davis and Dotson[6] 4) and by the FUTREX-5000™ Near-IR measurement. For the Near-IR measurements, the same multiple body sites were measured as for the skinfold measurements.

This *Technical Note* summarizes the initial test data. Specifically, it discusses the relationship of single site Near-IR measurement (on the prominent bicep) with hydrostatic weighing and describes the test, re-test reliability of the instrument. The results of the full technical study will be published in the scientific literature.

INSTRUMENT DESCRIPTION

The commercial instrument is a battery powered unit that includes an optical "light wand" attached to a chassis by a one meter cable (FIGURE 1). The light wand is a self-enclosed optical system that allows Near-IR energy to be generated at specific wavelengths and detected for quantitative measurement.

Measurements are made by placing the light wand on the anterior midline of the bicep halfway between the anticubital fossa and acrominion (e.g. halfway between the shoulder and the elbow at the "belly" of the muscle) of the prominent arm. This site was suggested by Conway *et al* as the best single predictor based upon a multiple regression model.

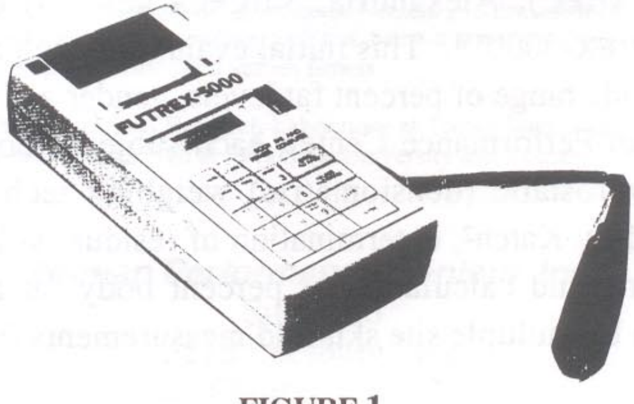

FIGURE 1

The instrument provides a direct digital readout of percent fat approximately two seconds after the wand is placed on the bicep. The measurement is based on a calibration equation built into the unit by the manufacturer.

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[5] Jackson, A.S. and M.L. Pollock. Generalized equations for the prediction of body composition . *Medicine and Science in Sports,* 10:47, 1978.

[6] Davis, P.O. and C.O. Dotson. Development of a simplified techniques for the determination of per cent body fat in adult males. *The Journal of Sports Medicine and Physical Fitness.* 25:255-261, December, 1985.

To compensate for possible optical or electronic drift, the instrument is supplied with an "optical standard". This is a cylindrical plastic device in which the light wand is inserted. Once it is inserted, a "ZERO ADJUST" push button is pressed on the chassis. This procedure automatically corrects for any instrument drift that may have occurred. Once the light wand is removed from the optical standard, it is ready to be used for measurements.

The diameter of the portion of the probe that comes in contact with the body is approximately 25% larger that that used by Conway. The manufacturer claims that this new geometry was selected to eliminate the prior measurement sensitivities to sex and race due to its greater penetration of the soft tissue.

SUBJECTS

All subjects executed an informed consent, and presented themselves for hydrostatic weighing in a post absorptive state. Subjects were normal volunteers, with no history of chronic disease. Physical activity habits were elicited through a verbal interview and recorded on a personal data form. For the purposes of this technical note, the data has been limited to a subject subset whose concordance of body fat percentage measurements were in general agreement with all three traditional methods of body composition determination. The range of percent fat varied from a minimum of approximately 10% to a maximum of 36.8%. The distribution of males and females were nearly equal.

TEST DATA

Test-retest reliability, assessed across several days on ten subjects of varying body composition, was 0.94 based on intraclass correlation. The mean of three measures yielded a reliability coefficient of 0.98. Concurrent validation of the current version based on hydrostatic weighing yielded an r of 0.83. Similar validation based on additional input measures increased the correlation to 0.92. This preliminary analysis of NIR suggests that body composition can be assessed with excellent reliability and good validity.

CAUTIONS TO BE OBSERVED

There are two measurement procedures where errors could be introduced if the operator does not properly use the instrument:

EXTERIOR LIGHT - The arm is rather transparent to bright sunlight or certain type of lamps. For this reason, the instrument is delivered with a black light shield that blocks the external light. If the light shield is not used in a brightly lit room measurement errors can occur (fluorescent lit rooms are not subject to these types of errors).

POSITION OF PROBE- The probe must be located accurately on the bicep. The light shield supplied with the instrument contains a location device that should be used.

CONCLUSION

The instrument manufacturer claims that the instrument provides the same accuracy as hydrostatic weighing. Our preliminary results confirm this finding; moreover, the instrument was easy to use, demonstrated measurement repeatability, and allowed an individual to perform his own measurements. The instrument allows a researcher to develop their own laboratory-dependent methodologies and population-specific equations based solely on NIR data, as well as NIR data in combination with more traditional measures of body composition.

AUTHORS

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