NHANES 2001-2002 Data Release
May 2004
MEC Examination

Bioelectrical Impedance Analysis (BIX_B)

Survey Years Included in this File: 2001-2002

Component Description:

BIA measures the electrical impedance of body tissues and can be used to assess fluid volumes, total body water, and fat-free body mass. The NHANES BIA measurements were collected as part of the Body Composition Component together with dual energy x-ray absorptiometry (DXA) scans in the Mobile Examination Center (MEC). A small alternating current was passed through surface electrodes placed on the right hand and foot and the impedance to the current flow was measured by different electrodes placed adjacent to the injection electrodes. The voltage drop between electrodes provided a measure of impedance, or opposition to the flow of the electric current.

BIA measurements include:

BIAEXSTS – status of the BIA examination
BIAOBJ – all jewelry, eyeglasses, hair ornaments, and other objects removed
BIXS005K-BIXS1M – 50 resistance values from 5 KHz to 1 MHz
BIXC005K-BIXC1M – 50 reactance values from 5 KHz to 1 MHz
BIDFIT – an indicator of BIA data quality

Eligible Sample and Component-Specific Exclusions:

Individuals ages 8-49 years who met any of the following exclusion criteria were not eligible for the BIA component:

Pregnancy
Amputations other than fingers or toes
Artificial joints, pins, plates, or other types of metal objects in the body
Pacemaker or automatic defibrillator
Coronary stents or metal suture material in the heart
Weight over 300 pounds (limitation for examination table)

The variable for pregnancy status is RIDPREG in the Demographics Data File.

The examination status of ineligible individuals was coded as “Not Done.” Other reasons for a “Not Done” status included no time for the examination, pregnancy test not completed, participant refusal, equipment failure, and questionable or bad data.

Examination Protocol:

The BIA data were collected with a HYDRA ECF/ICF Bio-Impedance Spectrum Analyzer (Model 4200) manufactured by Xitron Technologies, Inc., San Diego, California. The multi-frequency analyzer uses a full 12-bit digital signal processing technique to measure impedance at 50 frequencies logarithmically spaced from 5KHz to 1 MHz (1).

The BIA and DXA examinations were conducted in the same room. DXA was measured first, followed by BIA. Both examinations were conducted by trained health technicians, who were also responsible for BIA quality control procedures. The examination protocol is fully documented in the Body Composition Procedures Manual on the NHANES website at: http://www.cdc.gov/nchs/data/nhanes/bc.pdf

Quality Control during Data Collection:

Each time the BIA machine was turned on, it performed an automatic internal circuitry self-check that indicated if the machine was out of calibration or had a fault. An electronic verification module was used to complete weekly circuit testing. The Body Composition Procedures Manual details the BIA quality control tests performed.

Experienced trainers, NCHS staff, and contractor staff monitored health technician performance in the field. Retraining sessions were conducted with the technicians periodically and annually to reinforce the proper protocols and technique.

Data Processing and Editing:

The quality of the collected raw frequency data was evaluated through an external modeling program provided by Xitron Technologies, Inc. (1). The Hydra ECF/ICF measures resistance (R) and reactance (X) and calculates the reciprocal impedance (Z) and phase angle (θ) at each measured frequency. The Z and θ spectra data were fit to the Cole-Cole model (2) using iterative non-linear curve-fitting software (3). The modeling program evaluates the weighted least square error of both Z and θ, where the weighting is established by the published accuracy specifications of the machine and removes any frequency that would significantly decrease the total weighted least square error. The expected accuracy at each measured frequency is established as a pair of arrays (Z and θ) at the start of the modeling function. The error ratio is then established at each modeling point by dividing the modeling error by the corresponding stored array errors. In addition to the correlation of fit using scalar Z, the program established the accuracy of data fit to the model. The BIDFIT variable provides the following codes for the accuracy of the fit:

- 0=Excellent fit to model
- 1=Good fit to model
- 2=Marginal fit to model
- 3=Questionable fit to model
- 4=Bad fit to model

If the data did not conform to the theoretical model, it was due to either an extreme biological deviation in the subject measured or poor measurement quality control (1). When less than 25% of the frequencies were beyond a very high characteristic frequency (Fc), the program rated the fit as “Marginal.” When less than 10% of the frequencies were beyond Fc, the modeling program rated the fit as “Questionable.” When less than 2% of the frequencies were beyond Fc, the program rated the fit as “Bad.”

The modeling program was not used to conduct data analyses or to calculate estimates, but simply to determine the quality of the data as one step in the quality assurance process. Whenever the fit of the data was questionable or worse, the observations were excluded from the release dataset. The status of individuals with a BIDFIT value of 3 or 4 was coded as “Not Done.”

Component-Specific Analytic Notes and File Variables:

Before beginning analysis, users are advised to review the BIDFIT values to identify the quality of the data to be analyzed.

NCHS Research Data Center:

No data related to this component are in the Research Data Center.

References:

1. HYDRA ECF/ICF Bio-Impedance Spectrum Analyzer (Model 4200). Operating Manual, Revision 1.01. Xitron Technologies, Inc., San Diego, California.

2. Cole KS. 1972. Membranes, Ions, and Impulses. University of California Press, Berkley.

3. De Lorenzo A, Andreoli A, Matthie J, and Withers P. 1997. Predicting body cell mass with bioimpedance using theoretical methods: a technologic review. J Appl Physiol 82(5)1542-58.