Thornton

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REPLY TO
ATTN OF: DD4-73-M-02

MEMORANDUM

TO: DD/Chief, Health Services Division

FROM: DD4/Charles E. Ross, D.O.

SUBJECT: The Problem of Body Weight Loss and Accurate Measurement

A decrease in weight may result from a decrease in body water, lean body mass (weight of muscle, bone and organs), or depot fat. The clinical considerations of weight loss vary, depending on which body constituents decrease in weight. To clarify the role of weight loss and excessive fat deficit ways of measuring the ratio of fat to total body weight are being studied.

Methods for evaluating total body fat include measurement of body density (weight per unit of volume), measurement of body water content (hydrometry), and total body radiopotassium content using whole-body scintillation counters.

Densimetric techniques are based on the fact that fat has the lowest density of any body constituent. The density of fat is 0.90; the density of the lean body mass is 1.10. Therefore, a loss of body fat results in an increase in specific gravity in a precise inverse relationship. Body density is usually determined by application of Archimedes' principle of under-water weighing.

Total body water is related to body fat, presuming fat to be anhydrous and water to be a relatively constant proportion of lean body mass. The whole-body scintillation counter determines the potassium content of lean body mass by measuring the emission of the radio-isotope K-40, which is 0.119% of naturally occurring potassium. Total body potassium correlates with lean body mass because potassium is absent or present in only trace amounts in fat.

Other valuable research techniques for estimating lean body mass include anthropometric measurements, creatine excretion, and basal oxygen consumption.

Measurement of skinfold thickness by a caliper provides a simple and reproducible measurement of subcutaneous fat (about 50% of total fat) and an index of total body fat. The relation of skinfold thickness to body fat content is practically independent of height. Various sites have been used for skinfold measurements but the triceps skinfold thickness is recommended because it is easiest to measure and gives highly reproducible results. Also, the triceps skinfold appears to be the most representative of total body fat, regardless of disproportionate distribution of fat tissue in various areas of the body. The triceps skinfold is measured at the back of the right upper arm exactly midway between the acromion and olecranon processes. Measurement is made of the double thickness of the pinched skin plus the attached subcutaneous fat tissue. No advantage is gained by using additional skinfold measurements.

The body fat represents approximately 11% of total weight of 20-year old men. Body fatness increases with age and in men increases approximately 100% from age 20 (13.6% fat) to age 50 (26.6% fat). Muscle mass decreases from 32.6% at age 20 to 19.5% at age 50. During this age range (20 - 50) the remaining lean body mass (bones, organs) of a man remains essentially unchanged (53.8%).

Men less than 30 years of age, whose triceps skinfold exceeds the mean by more than one standard deviation, are designated as obese. It is recommended that the standard established for men 30 years old be applied to men from 30 to 50 years of age.

Recommendations for accurate measurement of body weight loss during Skylab Missions:

1. Institute triceps skinfold thickness measurements preflight, inflight, and postflight.

2. Determine an adequate list of anthropometric measurements to be performed during preflight and postflight medical examinations and also possibly inflight.

3. Determine the total body radiopotassium content, using a whole-body scintillation counter, during preflight and postflight medical examinations. This technique can be performed at MSC with existing equipment.

4. An adequate correlation of body weight changes in relation to protocol and individual exercise must be made - both in the 1g environment and in the 0g Skylab environment. The methods of 1 and 2 in conjunction with accurate weight (mass) measurement is suggested.

5. Based on Apollo and SMEAT data, a continuation of Stereophotogrammetry should be considered for the Skylab pre- and postflight medical examinations. This technique would possibly be of more usefulness in conjunction with the other proposed measurements which could be included on the photos.

6. The utilization of the current method to measure body mass change along with the triceps skinfold caliper technique and possible anthropometric measurements would enable the dietary intake control system to assume a more sensitive medical position. This is of course, if the individual exercise is also strictly interfaced for interpretation with the dietary intake control system.

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