Healthcare Re-imagined

GE is dedicated to helping you transform healthcare delivery by driving critical breakthroughs in biology and technology. Our expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, and biopharmaceutical manufacturing technologies is enabling healthcare professionals around the world to discover new ways to predict, diagnose and treat disease earlier. We call this model of care “Early Health.” The goal: to help clinicians detect disease earlier, access more information and intervene earlier with more targeted treatments, so they can help their patients live their lives to the fullest.

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Looking beyond the bathroom scale

Accurate measurement of body composition provides valuable information for assessing, monitoring and treating a variety of diseases and disorders.

Most people are used to stepping on a scale at every visit to a doctor’s office. But monitoring patients’ weight—while helpful—is at best a crude and an imprecise way to assess their health. Today’s body composition measurement tools provide far more complete and precise information that can help support diagnoses and guide treatment. They can even help athletes make decisions on the training regimens they use to achieve the best performance.

Body composition measurement with dual-energy X-ray absorptiometry (DXA) can look beyond weight and the traditional body mass index (BMI) to determine body fat distribution—an important risk factor in a variety of serious diseases. More broadly speaking, information from DXA exams can prove valuable information in assessing a wide range of conditions, such as:

- Obesity
- Nutritional health
- Eating disorders
- Renal failure
- Wasting syndrome
- Cystic fibrosis

In all these cases, body composition measurement contributes to a thorough patient evaluation and helps clinicians monitor the effects of therapy, diet or exercise.

Body composition scans with DXA provide precise and accurate data on bone and tissue composition, including bone mineral density (BMD), lean tissue mass, and fat tissue mass. They provide both total body data and regional results (trunk, arms, legs, pelvis and android/gynoid regions). The measurements are fast and non invasive.

Clinical obesity

Obesity is linked to many debilitating and life-threatening disorders. Body mass index gives a simple anthropometric measurement of obesity, but recent data shows that the regional distribution of excess body fat is an important independent risk factor.

Those at greatest risk are now thought to be those with central obesity—high levels of upper body (abdominal) fat.

Obesity has reached epidemic proportions globally, with more than 1 billion adults overweight— at least 300 million of them clinically obese. An estimated 22 million children under five are estimated to be overweight worldwide.
Assessment of body composition is important in evaluating and managing severe eating disorders such as anorexia. Nutrition also plays an important role in skeletal mineralization. It is well known that women with anorexia nervosa more easily develop osteoporosis. Patients with anorexia lose a substantial amount of lean tissue, accounting for from 15% to 45% of the loss of total body mass. Much of this loss in lean tissue is muscle. Clinicians treating anorexia use body composition with DXA to:

- evaluate disease severity by setting target values of lean and fat
- monitor changes in both lean and fat compartments, and
- measure the effectiveness of nutritional interventions.

As one study found, “A key advantage of DXA is that changes in bone mineral density, fat and lean mass can be monitored. Weight scale measures general weight change, but without specific differentiation of changes in fat and lean mass for the total body or in various regions of interest.”

Nutritional therapies must not only increase fat tissue, but must also re-establish the normal relationship of fat to lean tissue. Young women with eating disorders have an increased risk for osteopenia, and osteoporotic fractures later in life.

Malnutrition is also a major factor in the greatly increased morbidity and mortality in patients with chronic renal failure. Studies show that change in whole body lean-tissue mass correlates strongly with change in body weight after hemodialysis. Renal failure also affects the skeletal constitution: Patients with renal dysfunctions are at significantly higher risk of primary and secondary osteoporosis.

Guiding treatment for wasting syndrome from AIDS/HIV

Wasting syndrome, defined as weight less than 90% of ideal body weight, is a devastating disease and a consequence of HIV infections, cancer, and heart, liver and celiac diseases. Accurate determination of body composition with DXA has value in assessing the extent of gender-specific muscle wasting and fat loss. The information can be used to monitor the effects of pharmacological and nutritional programs aimed at preventing or treating wasting syndrome of AIDS/HIV.

User-adjustable %fat threshold: To visualize high %fat regions. Bone image. Color % fat mapping.
Helping athletes make decisions on training regimens

The value of body composition measurement is not limited to treating illnesses – it can help some of the healthiest. Most athletes benefit from a lean body composition (low body fat percentage). In general, body fat beyond the amount needed for good health reduces efficiency. Athletes can achieve the body composition they desire through training and a proper diet.

Experts say the key is to track how much body fat athletes lose instead of relying on the bathroom scale. Height/weight tables based on BMI do not distinguish muscle from fat and so are not useful for high-performing athletics. A recent study in the United States by Oates et al. suggest that “DXA values may be more fundamental and less affected by anthropometric variables, or at least more precisely determined than the values for the other techniques”.

For highly trained athletes, even a small change in body composition can significantly affect performance. Body composition monitoring provides valuable information that athletes and their trainers can use to adjust diet and training regimens. Body composition measurement helps establish a starting point and a target, helping any athlete to pursue a specific goal.

Importance of Regional Analysis

Body composition provides important total body as well as regional information for sports medicine applications. Women who participated in an exercise program demonstrated a striking difference in tissue response in the arms and legs. Total body fat showed the expected beneficial loss with exercise, along with an increase in lean tissue. Regional analysis, however, showed that arms lost considerable fat, but no lean tissue, while legs increased lean with no increase in fat tissue. Women who exercised regularly also did not show an increase in central adiposity with age that is frequently found in sedentary women. This important finding would have been missed without regional analysis of body composition. Moreover, profound changes in body composition in athletes may be an indication of serious health concerns, including eating disorders, amenorrhea, and osteopenia or osteoporosis.

“Size, of course, is a desirable attribute in football... But mass without accompanying muscle is dead weight.”
– Wall Street Journal, October 5, 2005

Monitoring athletes’ body composition is easier now than ever: Trending capability allows direct comparison of total and regional tissue. Body composition monitoring also assesses bone health, which is crucial for overall health assessment.
DXA body composition measurement

More powerful than ever

Clinicians today consider DXA the gold standard for body composition because it accurately shows exactly where fat is distributed throughout the body. Lunar DXA systems directly measure total fat, lean and bone tissue, instead of estimating body composition.

DXA systems must perform at the highest precision possible. In fact, experts agree that in monitoring patients over time, it is crucial to get consistent results. Lunar DXA systems are backed by numerous studies that demonstrate high accuracy and precision in total body measurement.17

The precision of Lunar DXA systems is enabled by TruView image reconstruction technology, which eliminates the magnification and distortion inherent in traditional wide-angle fan-beam technology. TruView assesses the size of the anatomy accurately without making assumptions, providing true area and body composition measurements.

When measuring total body composition it is critical to take the entire body into account: bone, fat, and lean tissue. Lunar DXA systems calibrate across a full range of values, rather than calibrating to an average patient.

Lean mass includes all parts of the body (organs, muscle, and fluids) but excludes body fat. The higher the Tissue %Lean, the more muscular the body.

Fat mass includes all fat in the body.

Bone mineral density (BMD) is a measure of bone health. BMD is determined using DXA technology.

1. **BMD (g/cm²)**
   - **Age (years)**
     - 20: 1.383
     - 30: 1.262
     - 40: 1.183
     - 50: 1.100
     - 60: 1.000
     - 70: 0.975
     - 80: 0.971
     - 90: 0.871
     - 100: 0.777

2. **Y-A T-Score**
   - **Age (years)**
     - 20: 2.0
     - 30: 1.5
     - 40: 1.0
     - 50: 0.5
     - 60: 0.0
     - 70: -0.5
     - 80: -1.0
     - 90: -1.5

3. **BMD Age**
   - **BMD (g/cm²)**
     - **Age (years)**
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       - 30: 1.262
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       - 50: 1.100
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4. **T-Score**
   - **Age (years)**
     - 20: 2.0
     - 30: 1.5
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     - 50: 0.5
     - 60: 0.0
     - 70: -0.5
     - 80: -1.0
     - 90: -1.5

A bone densitometry test helps your physician to diagnose osteoporosis. The test compares your Bone Mineral Density (BMD) to that of a “young adult” at peak bone strength, displayed as your T-score. It also compares your results to people of your same age, called “age-matched” displayed as your Z-score. This information, along with other factors, helps physicians assess your risk of osteoporotic fracture. The difference between your result and that of a “young adult” is given as a T-score. A panel of experts at the World Health Organization (WHO) has developed categories that define the amount of bone loss:

- **Normal**: T-score is above -1
- **Osteopenic**: T-score between -1 and -2.5 (low bone density)
- **Osteoporotic**: T-score below -2.5

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The array detector of Lunar fan beam DXA technology comprises of cadmium/zinc telluride elements. These elements are used to directly convert the X-rays into a digital signal. Lunar DXA makes use of a narrow 4.5 degree angled fan type beam kept parallel to the longitudinal axis of the patient, which scans in a transverse pattern across the body of each patient. The mode of operation is such that these fan beams pass and overlap slightly with each other by a slight margin to ensure that no anatomical part is left unscanned. However, due to the overlapping, multiple images are created in return. These overlapping images when acquired and slid over each other for a match provided the actual distance of the sample object from the detector. By sliding these overlapping images together for a match (multiple view image reconstruction), the true distance of the object from the detector can be determined.

thus reducing magnification effects on the determination of BMC, bone area, and soft tissue. The amount of absorbed energy from the X-ray source is directly proportional to BMC and BMD, which is measured with a precision of 1%

Indications for use:

1. The GE Lunar Body Composition Software option (body composition) used on GE Lunar iDXA™ bone densitometer (low/medium, whole body, half body) scans measures the bone mineral density (BMD), lean and fat tissue mass and calculates bone mineral content (BMC), soft tissue mass, soft soft tissue mass, regional soft tissue, and regional % fat, region % fat, total body % fat, Asian % fat, % fat, Asian % fat. BMC and BMD, which is measured with a precision of 1%.

Consider these advances in DXA, available from GE Healthcare, Lunar:

Lunar Prodigy™
Prodigy’s direct-digital technology eliminates the magnification effects of traditional wide-angle fan-beam densitometers. With more than 5,000 systems installed worldwide, Prodigy is one of the most trusted fan beam densitometers available.

References:

1. The International Association for the Study of Obesity.