BELLY FAT ASSESSMENT: AN OVERVIEWOF UPDATES

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Abstract: Belly fat, also known as abdominal fat or central obesity, is the build-up of excess fat in the abdominal region, particularly in the midsection.Belly fat includes subcutaneous fat as well as visceral fat. Visceral fat is an important indicator of overall health and is linked to numerous negative health outcomes. This review focuses on the various techniques direct and indirect and tools to measure belly fat including visceral fat. It is essential to monitor and reduce visceral fat levels to improve overall health and prevent chronic diseases.

Key Words: Belly Fat, Visceral fat, Anthropometry, Bioelectrical impedance analysis.

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Body Composition

Body composition refers to the proportion of different components in the body, including muscle, bone, water, fat, and organs.[1]It is an important aspect of overall health and fitness and can impact various physical and health-related factors. Some of the reasons why body composition is important include weight management, metabolic health, physical performance, and Health Risks. Body composition can affect weight management as different components in the body have different weights. For example, a pound of muscle weighs the same as a pound of fat, but muscle takes up less space in the body than fat. Understanding body composition can help individuals make informed decisions about their weight goals. Body composition also affects metabolic health as different components in the body have different metabolic rates. For example, muscle burns more calories than fat, even when at rest. This means that having more muscle can increase the number of calories burned each day and help maintain a healthy weight.

Further type of body composition can affect physical performance as different components in the body have different functions. For example, muscle provides strength and power, while fat can serve as energy storage. By understanding body composition, individuals can tailor their exercise and nutrition to improve physical performance. Body composition can also affect health risks as different components in the body have different effects.[2] For example, having too much body fat can increase the risk of chronic diseases such as heart disease, diabetes, and certain types of cancer.[3] Understanding body composition can help individuals reduce their health risks and maintain optimal health. Thus, Body composition analysis is a useful tool for monitoring weight loss and muscle gain, as well as for tracking changes in body fat and muscle mass over time. It is also helpful for setting and tracking fitness and health goals.[4]

Belly Fat

Belly fat, also known as abdominal fat or central obesity, is the buildup of excess fat in the abdominal region, particularly in the midsection. It include various components such as subcutaneous fat which is the most common type of belly fat that lies just under the skin and is easily visible and is soft and pinchable and can be reduced through diet and exercise while the visceral fat located deep inside the abdominal cavity and surrounds the organs, referred to as "active fat" because it is metabolically active and has a direct impact on health. Other names for belly fat are based on physiological and pathological condition such as “Hormonal Fat” seen in endocrine disorders such as high levels of cortisol, insulin or estrogen can lead to increased belly fat; women tend to store more belly fat in this manner, particularly after menopause; lastly belly fat can be age-related fat as we age, our metabolism slows down, leading to increased belly fat. This type of belly fat is often referred to as "senior belly”; another factor is stress-related fat seen in chronic stress which can increase cortisol levels, leading to increased belly fat storage. This type of belly fat is often referred to as "stress belly”.Lastly, it can be genetics related. Fat with some people may be predisposed to storing more fat in the abdominal area, due to

genetics. This type of belly fat is often referred to as "genetic belly."

It is the type of visceral fat, which gets stored around the internal organs and can pose serious health risks. Abdominal fat assessment is an important health indicator tool and increased abdominal fat is associated with an increased risk of heart disease, stroke, and other cardiovascular problems. Further, Abdominal fat is metabolically active and produces hormones and cytokines that can negatively impact glucose and insulin metabolism, leading to type 2 diabetes and metabolic syndrome. Abdominal fat also increases risk for cancer and its higher levels are associated with an increased risk of certain types of cancer, such as colorectal and breast cancer.[5]

Abdominal fat is also a source of inflammation, which can lead to various health problems. Affecting overall quality of life with associated physical discomfort, reduced mobility, and decreased quality of life. Visceral fat, also known as intra-abdominal fat, is the fat stored within the abdominal cavity and surrounding internal organs, such as the liver, pancreas, and intestines. It is different from subcutaneous fat, which is found under the skin. Metabolic syndrome: Visceral fat is a key component of metabolic syndrome, which is a group of conditions that increase the risk of heart disease, stroke, and type 2 diabetes. Similarly, visceral fat is strongly linked to insulin resistance and the development of type 2 diabetes.

The assessment of abdominal fat is important for evaluating a person's overall health status and for identifying those at risk for health problems. It is a valuable tool for healthcare providers to monitor changes in abdominal fat over time and to make recommendations for lifestyle changes and medical interventions that can improve health.

Thus, there are two main types of adipose tissue in abdominal fat; namely subcutaneous fat which lies directly under the skin. It is the most common form of abdominal fat and can be measured with a measure tape. The other type is visceral fat located in the abdominal cavity, surrounding the internal organs such as the liver, intestines, and stomach. Both subcutaneous and visceral fat can contribute to abdominal fat, but visceral fat is generally considered to be a greater health risk.

Assessment of Belly Fat

Along with assessment of overall body composition, the assessment of belly fat is of particular importance. It can be done using various direct and indirect methods, including but not limited to Body Mass Index (BMI), Waist Circumference, Skinfold thickness measurement, Bioelectrical Impedance Analysis (BIA), Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI) and Ultrasound. It is well understood that metabolic and cardiovascular diseases are closely related to visceral fat development in humans. Persons at risk of having metabolic disorders in future would greatly benefit from estimations of visceral fat and will be able to provide reference to serve as benchmark for the prevention and treatment illness related to visceral fat.[6.7]

A. Indirect methods:

1. Anthropometry measurement:

i. **Waist Circumference (WC**)- Measuring the circumference of the waist is a simple and reliable way to assess abdominal fat. A waist circumference of more than 88 cm in women and 102 cm in men is considered as an indicator of abdominal obesity. Waist circumference is an index of central obesity recommended by the National Institutes of Health, WHO, the American Heart Association, and the International Diabetes Foundation for screening for risk of metabolic and cardiovascular disease,[8.9] though there is no consensus on the best anatomic location to measure waist circumference; WHO recommends the midpoint between the last palpable rib and the iliac crest, and the National Institutes of Health recommends the level of the umbilicus.

ii. **Waist-to-Hip Ratio** - This is calculated by dividing the waist circumference by the hip circumference. A higher waist-to-hip ratio indicates an increased amount of abdominal fat.WC is positively associated with cardiovascular disease, diabetes and premature mortality, the opposite is true of HC. Recent studies show that combining WC

and HC as a ratio is inappropriate, and yet their individual roles can only be fully elucidated if considered jointly.

iii. **Skinfold thickness measurement**: This measurement is taken with a skinfold caliper, which is used to pinch a fold of skin and measure the thickness. This measurement can provide a more accurate assessment of body fat distribution, including abdominal fat. Further, the subcutaneous fat measurement errors in skinfold thickness at various sites tends to increase with increasing obesity levels. This influence is smaller for the abdominal and suprailiac skinfolds compared with other sites.

iv. **Body Mass Index (BMI)** - This is calculated by dividing an individual's weight in kilograms by the square of their height in meters. A BMI of 25 or higher indicates an increased risk of abdominal obesity. BMI (body mass index) is not a direct indicator of visceral fat. Other factors such as waist circumference, waist-to-hip ratio, and CT scans or MRI can be used to measure visceral fat.

2. **Conventional Bioelectrical Impedance Analysis (BIA):** This test uses a small electrical current to determine body fat and lean body mass. BIA can provide a more accurate measurement of body fat, including abdominal fat. Earlier versions for Bioelectrical Impedance Analysis (BIA) have been widely used in clinical settings and epidemiological studies as it is safe, easy, and non-invasive technique for measuring body composition.[7]

3. **Dual-Energy X-ray Absorptiometry (DXA) -** DXA is a medical imaging technique that uses low-dose X-rays to measure bone density and the body composition, including fat mass, lean mass, and bone mass. DXA is primarily used to diagnose and monitor osteoporosis, but can also provide information on body fat distribution, including abdominal fat. DEXA method however cannot discriminate between visceral and subcutaneous fat depots. It is important to note that DXA is not the most precise method for measuring abdominal fat, and other methods such as CT scans or MRI may be more accurate.

4. **Three-dimensional (3D) body scanning:** This technology involves capturing the shape of a person's body by projecting laser or other forms of light onto their surface and using a system of cameras to record the reflection(8). These cameras can quickly gather numerous measurements of the body's linear, circumferential, and volumetric dimensions. The laser-based method is more accurate than the optical camera-based method, but it is also less expensive. 3D body scanning can be used to create new measurements of central obesity, such as abdominal volume and body shape, to predict the amount of abdominal fat and the associated health risks.

B. Direct method:

1. **Newer Bioelectrical Impedance Analysis (BIA):**BIA technology got modified from earlier generalized measurement of overall body fat mass to specifically estimating visceral fat area (VFA). Recent technology based on newer applications can place the electrical plate directly on the abdomen or applying hand-to-foot or leg-to-leg mode BIA(9,10). When compared to the conventional BIA, the direct abdominal impedance BIA measuring device, the hand-to-foot mode or leg-to-leg mode, are quite accurate and widely used for estimating individual VFA due to their low cost, convenient, and prolonged developmental history.[11.12] By combining the use of BMI and anthropometric parameters, it will help to estimate visceral adipose tissue, since BIA alone is inadequate to measure VAT, when the level of BMI increases.[13,14]

2. **Computed Tomography (CT) scan** - This is an X-ray-based imaging test that can produce detailed images of the abdominal area, allowing for the precise measurement of abdominal fat.CT directly measure VAT areas or volumes and it is considered reference method for evaluating abdominal adiposity. CT scan method for abdominal fat

measurement has an advantage that it is less likely to be influenced by breathing artifact.[15] The only limitation is risk associated with the ionizing radiation from CT which limits its use in children and in longitudinal studies. Single-slice CT scan images are often used to measure abdominal adiposity for its simplicity and to reduce radiation exposure at L2–L3 location best estimates total VAT volume. Cost and availability of this technique often limits its use for research purposes. The brown adipose tissue (BAT), which is considered as metabolically active fat can be measured with the PET-CT.

3. **Magnetic Resonance Imaging (MRI):** This is an imaging test that can provide a detailed image of the body's internal structures, including fat deposits. It is one of the most accurate methods of measuring abdominal fat. MRI system is safe with no risk of radiation exposure and can used in children and in longitudinal studies. Studying brown adipose tissue (BAT) through PET-CT, which involves ionizing radiation, may not be the best option. MRI could be used as an alternative, however, there are still technical challenges in determining the accuracy of BAT quantification based on fat fraction. MRI with various pulse sequences and scan parameters allow for accurate and detailed characterization of the fat and other soft tissues. The fat-selective MRI, chemical-shift-encoded water-fat MRI, and magnetic resonance spectroscopy techniques are particularly useful for this purpose of measuring metabolically active fat. Most MRI systems have 60 cm bores, which may not accommodate individuals with severe obesity, although individuals with up to an approximate BMI of 47 have been scanned with 60 cm bore size scanners. However, recent MRI systems with 70 cm bore are becoming increasingly available.
4. **Ultrasound:** An ultrasound uses high-frequency sound waves to produce images of the body and can provide an accurate measurement of visceral fat.Currently, B-mode ultrasound is more commonly used than A-mode ultrasound in obesity studies. There is component of variability with USG being subjective technique. Though ultrasound can reliably estimate abdominal fat thickness, whereas the validity and reliability of ultrasound for measurement of adipose tissue areas needs further study.[16,17]

Measurement of metabolically active abdominal fat (Brown Vs. White adipose tissue): Brown adipose tissue (BAT), as a metabolically active tissue, is closely related to energy regulation and obesity in humans. The study found that activated BAT was primarily located in the peri-renal and para-renal fat but was not detected in other areas such as the subcutaneous adipose tissue, omental, or mesenteric VAT. The activation of brown adipose tissue was found to vary between obese and lean men in a recent PET-CT study conducted in a cold environment. The results showed that obese men had a reduced activation of BAT, particularly in the abdominal region, compared to their lean counterparts. The techniques like PET-CT, MRI, and dual energy CT can distinguish BAT from white adipose tissue.[18]

It is important to remember that no single measurement can accurately assess abdominal fat. The best way to assess abdominal fat is through a combination of measurements, including waist circumference, body mass index, and skinfold thickness measurement or bioelectrical impedance analysis.[19]Further, these techniques should be performed by trained healthcare professionals, and results should be interpreted in conjunction with other factors such as age, gender, and overall health status. Each method has its own advantages and disadvantagesbut skinfold calipers and BIA are the most used for measuring body fat in general populations.[20] DXA and MRI are more commonly used in research settings,due to their high accuracy but also their high cost.[21]

Conclusion:

Belly fat includes subcutaneous fat as well as visceral fat. Visceral fat is an important indicator of overall health and has been linked to numerous negative health outcomes. It is essential to monitor

and reduce visceral fat levels to improve overall health and prevent chronic diseases. There are various direct and indirect techniques and tools to measure the belly fat including visceral fat. Based on the advantages and limitation related to accuracy and feasibility, no single techniques are best suited across all age, gender and amount of belly fat including visceral fat. It is advisable to combine at least 2-3 methods to accurately measure and estimate it.

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