SKINFOLD THICKNESS MEASUREMENT & ANTHROPOMETRY

WHAT YOU NEED TO KNOW:
FROM THEORY
TO PRACTICE

LIPOWISE

TITLE

Skinfold thickness measurement & Anthropometry

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CONTENTS

04

PRESENTATION

THE IMPORTANCE OF BODY COMPOSITION

A healthy nutritional status throughout one's life-course prevents noncommunicable diseases and conditions and is essential for the health, growth, development and economic well-being of individuals and populations.
Addressing nutritional status is critical to identify individuals or populations at risk of malnutrition, to refer them to proper nutritional care. Continuous assessment of body composition has a tremendous impact on the prevention and treatment of malnutrition in all its forms, while also monitoring the nutritional situation of a population.

In clinical settings, anthropometry is considered the method of choice for body composition assessment.
This e-book presents information on the fundamentals of anthropometry, skinfold thickness measurements and their standard techniques. Lipowise is also presented as the new digital skinfold calliper that addresses the limitations of traditional callipers and makes the measurement protocol easier.

05

ANTHROPOMETRY

Anthropometry, derived from the Greek words meaning "human" and "measure", is defined by the measurement of the dimensions and composition of the body: size, weight and proportions.

In clinical settings, anthropometry is considered the method of choice for the assessment of body composition.

MEASUREMENTS AND INDICES

To evaluate individuals, anthropometry relies on several different types of measurements, such as length/height, weight, circumferences, diameters, or sinkfold thickness.

When two or more anthropometric measures are combined together, with age or with sex, an anthropometric index or ratio can be calculated, resulting in body mass index (BMI, a combination of weight and height), BMI-for-age, waist-hip ratio, and many other examples.

Anthropometry compares each of the measurements taken with the available and most appropriate standards, references or cut-offs, to determine the anthropometric status of an individual or population.

- A **standard** can demonstrate how healthy an individual is under ideal circumstances.
- A **reference** describes what a specific population is like, without necessarily reflecting optimal status.
- A **cut-off** is a threshold beyond which an individual is determined to be malnourished. It also identifies the severity of undernutrition or overweight/obesity in an individual.

In addition to the above definitions, to determine the nutritional status of a given population it is important that anthropometric data and anthropometric indicators are compiled together with information about the local context and trend data. If necessary, this combination can clearly describe the type and magnitude of nutritional issues in a population.

- An **anthropometric indicator** is an objectively verifiable quantitative measure that reflects the nutritional status of an individual or population.

Anthropometric indicators are developed from anthropometric measures or indices and can monitor changes in a situation over time or to demonstrate whether a program is achieving its goals.

Based on the information from different benchmarks, standards, cut-offs and indicators, individuals can be classified, according to Food and Nutrition Technical Assistance (FANTA), into one of four different categories:

- **Normal nutritional status;**
- **Undernourished;**
- **Overweight;**
- **At risk of malnutrition.**

Most of the time this classification is also sex-specific. The classification also indicates the magnitude in each category.

ANTHROPOMETRY USES

Anthropometric data has different uses in individuals and populations, but together it provides information about nutritional status: it helps identify nutritional trends, possible problems, and appropriate corrective actions. Here are some additional examples:

Individual use of anthropometric data:

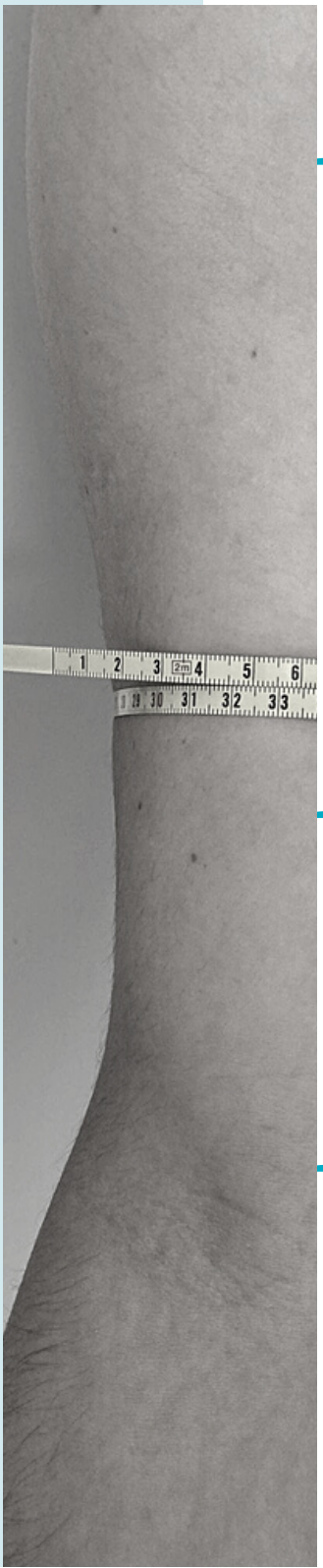
- Nutrition Assessment and Screening.

Population use of anthropometric data:

- Nutrition Surveillance;
- Influencing Policy and Strategy Development and Funding Levels;
- Program Targeting, Design, and Planning;
- Monitoring and Evaluation;
- Global Tracking of Development Status;

08

GIRTHS, LENGTHS AND BREADTHS



For a complete assessment of all body measurements, there are some predetermined measurements of specific girths, lengths and breadths.

Girths are measurements of circumferences around the body at standard anatomical locations. They are measured with an anthropometric tape. Girth measurements can be used in determining body size and composition, and to monitor changes in these parameters.

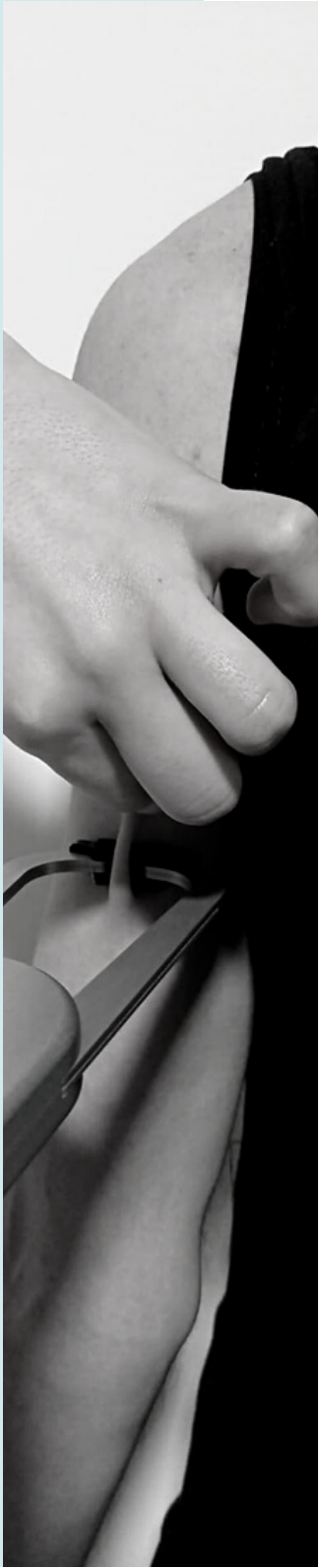
Girth measurements combined with skinfold measurements can give a clearer picture of changes in muscle and fat composition and distribution.

Breadth measurements are made at standard anatomical locations around the body, measured with a specific breadth measurement calliper.
The measurement is taken with the faces of the calliper placed at the bone landmarks.

Length measurements are made at standard anatomical sites around the body, measured with a tape measure, segmometer or calliper.
For this indicator, it is essential that the measurement is taken closest to the eye level.

09

SKINFOLD THICKNESS MEASUREMENTS



Taking skinfold measurements as a way to assess body composition, particularly body fat is a widely used method in various fields, from sports to clinical and research.

Skinfold Callipers are used to measure the thickness of a skinfold at various locations on the body and, according to the chosen equation, the anthropometrist can determine the percentage of subcutaneous fat.
The skinfold thickness technique is a highly informative, non-invasive, portable, and inexpensive method to determine body fat.

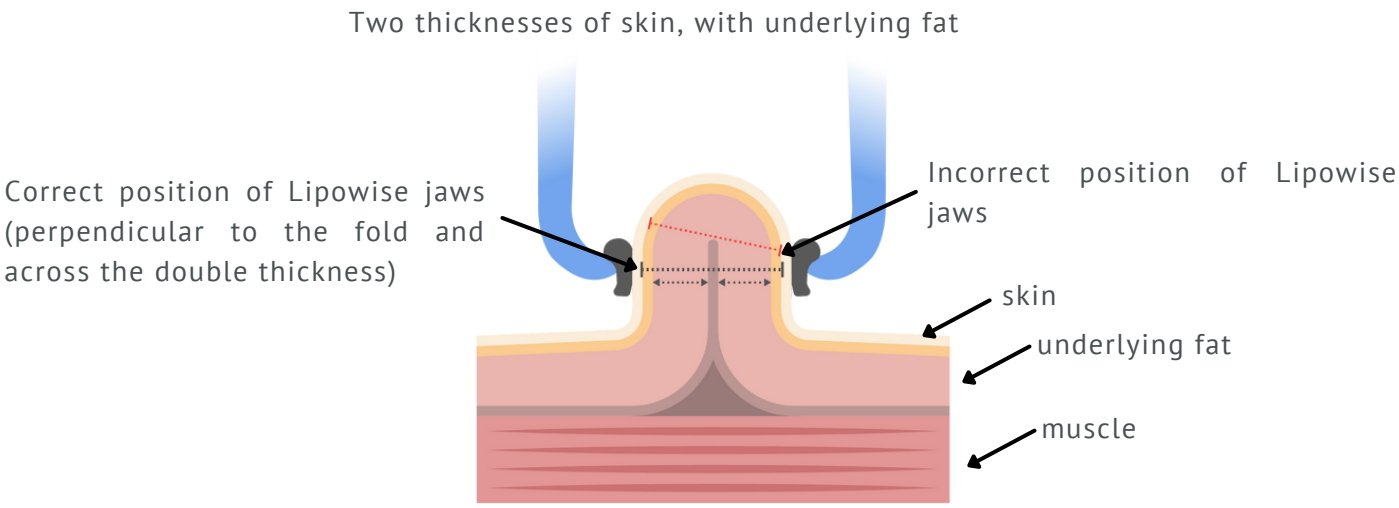
WHAT ARE SKINFOLDS?

To have a correct and accurate assessment of body composition, a measurement protocol must be performed.

When correctly measuring skinfolds, we must keep in mind that the skinfold consists of a double thickness of skin underlying adipose (fat) tissue. The examiner must carefully separate a fold of skin from the muscle that lies underneath.

10

To avoid any measurement errors, the examiner should not take a skinfold measurement if he cannot construct a fold with two thicknesses of skin and the correspondent underlying fat.



ADVANTAGES AND DISADVANTAGES

Measuring skinfolds using callipers has several advantages:

- **Portable method;**
- **Non-invasive;**
- **Accurate measurements (if correctly done);**
- **Localized assessment.**

In addition to the recognized advantages, body composition assessment using skinfold thickness measurement also has some limitations, due largely to the set of assumptions inherent to skinfold measurement, which include:

- **Constant compressibility;**
- **The thickness of the skin is negligible;**
- **The proportion of fat is constant in adipose tissue;**
- **Constant subcutaneous/visceral fat ratio.**

11

STANDARD TECHNIQUES

THE FIRST REQUIREMENT TO OBTAIN ACCURATE AND RELIABLE INFORMATION IS THAT THE EXAMINER MUST FOLLOW SPECIFIC PROTOCOLS AND HAVE PRACTICE IN PERFORMING THIS TYPE OF ASSESSMENT.

Historically, anthropometric procedures have been employed in various fields. Their use in multiple countries has led to different approaches, nomenclature, and practices.

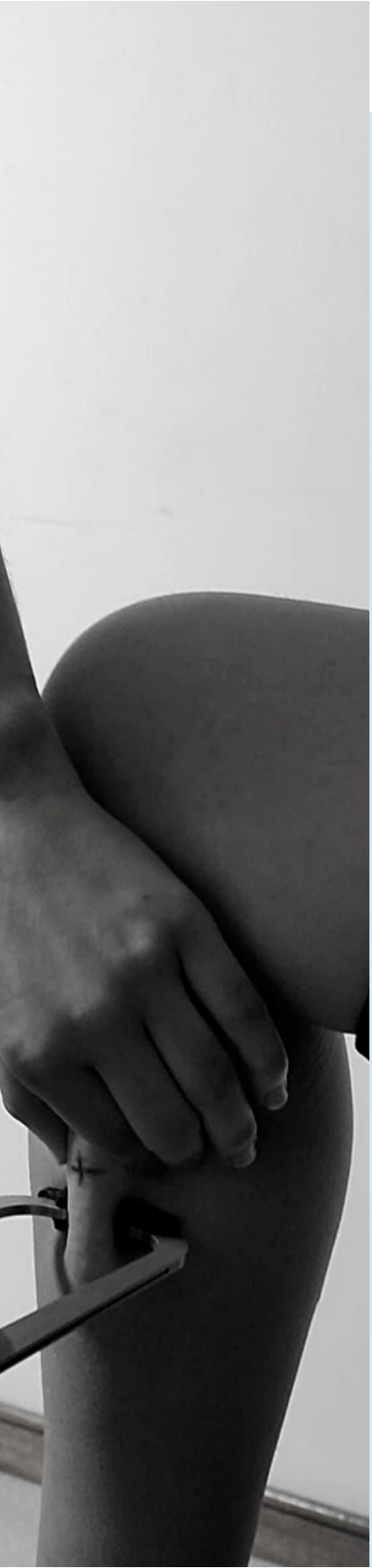
The techniques and specific anatomical positions for measurements are authoritatively described in several textbooks **(Norton and Olds, 1996; Lohman et al.,1988; Frisancho, 2008; Stewart & Sutton, 2012)** and also in the open-access **NHANES manual (Centers for Disease Control & Prevention, 2005)**

The **International Society for the Advancement of Kinanthropometry** (ISAK) was founded in 1986. ISAK has developed international standards for the anthropometric assessment and an International Accreditation Scheme for Anthropometrics (IAAS).

The ISAK approach has increased in popularity as it requires all measurements to pass an error control target in terms of reproducibility in a standardized setting.

THE ISAK PROTOCOL

Accurate measurements are extremely important. The standard procedures and general techniques to correctly take a skinfold measurement are described below:



1.Before taking the skinfold measurement, carefully mark the appropriate spot, using the correct anatomical landmarks, with a medical skin marker.

2. All marks should be made on the right side of the body.

3. The examiner should grasp and lift the skinfold between the thumb and index finger.

4. The fingers that form the skinfold are applied to the anatomical landmark.

5. The calliper is applied within 1 cm of the anatomical landmark.

6. The calliper is placed at a depth of approximately a mid-fingernail.

7. The calliper is held perpendicular to the surface of the skinfold site

8. During the measurement, the examiner should continue to hold the skinfold with the thumb and index finger.

9. Release the handle of the calliper to apply full tension on the fold.

10. The measurement is recorded 2 seconds after applying the full pressure of the calliper.

11. After recording the measurement result, remove the calliper jaws and only then release the skinfold.

- **It is recommended that skinfold measurements be taken alternatively to avoid any examiner bias. This means that a complete data set of the total number of skinfolds is taken before repeating the second and third times. This may also help avoid the effects of skinfold compressibility.**

- **Whenever possible, two measurements should be taken at each site. The examiner should take a third measurement if the second measurement is not within 5% of the first.**

- **To record the result for each skinfold, the median value of the repeated measurements is calculated.**

- **Measurements should be taken only when the individual to be measured meets the necessary conditions.**

The skinfolds illustrated below are those used in most predictive equations.

CHEEK

Horizontal fold;
Skinfold underneath the arcus zygomaticus, aligned with the lateral border of the orbit.

CHIN

Vertical fold;
Beneath the mandible, between the chin and the neck (above the hyoid bone).

AXILLARY

Vertical fold;
Intersection of two lines: horizontal line at the level of the lower end of the xiphoid process (the lower end of the sternum or breastbone) and a vertical line in the middle of the armpit.

BICEPS

Vertical fold;
Anterior midline of the upper arm;
Halfway between the acromion (shoulder) and olecranon processes (elbow);
Arm held freely to the side of the body.

TRICEPS

Vertical fold;
Posterior midline of the upper arm;
Halfway between the acromion (shoulder) and olecranon processes (elbow);
Arm held freely to the side of the body.

SUBSCAPULAR

Diagonal fold;
1 to 2 cm below the inferior angle of the scapula.

ILIAC CREST

Almost horizontal fold;
At the intersection of the mid-axillary line with the most superior point of the iliac crest.

SUPRASPINALE

Diagonal fold;
Anterior axillary line immediately superior to the iliac crest and in line with the natural angle of the iliac crest taken.

ABDOMINAL

Vertical (modern technique): 2 cm to the right side of the umbilicus;
Horizontal fold (traditional): 2 cm to the right side of the umbilicus.

THIGH

Vertical fold;
Anterior midline of the thigh;
Midway between the proximal border of the patella (upper knee) and the inguinal crease (hip).

KNEE

Vertical fold;
2 cm above the proximal margin of the patella, in the mid-sagittal plane.

CALF

Vertical fold;
Maximum circumference of the calf on the midline of the medial border.

LOWER BACK

Horizontal fold;
5 cm to the right of the spine, over the kidney.

CHEST

Diagonal fold;
Men: one-half the distance between the anterior axillary line (crease of the underarm) and the nipple;
Women: one-third of the distance between the anterior axillary line and the nipple.

BODY FAT PERCENTAGE

HOW TO CALCULATE:

Skinfold thickness measurements can be **directly converted into body fat percentage (BF%) or it may require a first estimate of body density** using regression equations and further conversion into BF% using distinct prediction formulas.
When body density is calculated, it **requires conversion into BF% using specific equations**. Siri's and Brozek's formulas are the most commonly used for this purpose:

- **Siri** BF% = [4.950 / BD (kg/m3) – 4.500] x 100
- **Brozek** BF% = [4.570 / BD (kg/m3) – 4.142] x 100

When choosing the right, adjusted equation, the examiner should note that most formulas are specific to the group of people with the same characteristics as the sample where the formulas were generated.
The use of the predictive equations is dependent on several requirements. Thus, even if widely used, a predictive equation may not be suitable for the majority of the population.

The formulas depend on several criteria, such as:

- Sex
- Age
- Ethnicity
- Physical activity
- Nutritional status

EQUATIONS

We summarize the most commonly used formulas for different group populations.

EQUATION	Population	Triceps	Biceps	Subscapular	Iliac Crest	Supraspinale	Abdominal	Anterior thigh	Calf	Chest	Axillary
Durnin & Womesley (1974) - Triceps	M/F	X									
Durnin & Womesley (1974) - Subscapular	M/F			X							
Durnin & Womesley (1974) - 2 skinfolds	M/F	X		X							
Durnin & Womesley (1974) - 4 skinfolds	M/F	X	X	X	X						
Jackson & Pollock (1978) - 3 skinfolds	M						X	X		X	
Jackson & Pollock (1980) - 3 skinfolds	F	X				X		X			
Jackson & Pollock (1980) - 4 skinfolds	F	X				X	X	X			
Jackson & Pollock (1985) - 7 skinfolds	M/F	X		X		X	X	X		X	X
Jackson & Pollock (1985) - 3 skinfolds	M	X		X						X	
Jackson & Pollock (1985) - 3 skinfolds	F	X				X	X				
Peterson (2003)	M	X		X	X			X			
Peterson (2003)	F	X		X	X			X			
Visser (1994) - 2 skinfolds	E/M/F	X	X								
Visser (1994) - 4 skinfolds	E/M/F	X	X	X	X						
Slaughter (1988) - triceps + geminal	A/C/F/M	X							X		
Slaughter (1988) - triceps + subscapular	A/C/F/M	X		X							
Yuhasz (1974) - ISAK	M/F	X		X		X	X	X	X		
Withers (1987)	M						X	X	X	X	
Withers (1987)	F	X		X		X			X		
Novel (2009)	M	X					X	X	X		
Guedes (1994)	M	X			X		X				
Guedes (1994)	F			X	X			X			

A: Adolescents; C: Children; E: Elderly; M: Male; F: Female

By converting skinfold measurements to body fat percentage, we could be introducing new errors or assumptions into the final result. With this in mind, some examiners find it more interesting and accurate to use the sum of several skinfold measurement sites to monitor and compare body fat measurements.
The recommendation is to use the sum (in millimetres) of 6 and/or 8 skinfolds:

- **∑6:** Triceps, subscapular, supraspinale, abdominal, thigh, and calf.
- **∑8:** Triceps, biceps, subscapular, supraspinale, iliac crest, abdominal, anterior thigh, and calf.

ERROR IN SKINFOLD THICKNESS MEASUREMENT

The use of anthropometry, especially skinfolds to assess body composition has proven to be an accurate and reliable method even when compared to more expensive equipment such as the DXA system or Computer Tomography. However, as we said earlier, to trust the data obtained by using the calliper, the examiner must follow a standardized protocol and have some practice in performing skinfold measurement.

Technical error of measurement (TEM) is an index of precision to express the margin of error in anthropometry, which also represents quality control of measurements. It has been adopted by ISAK for accreditation. The TEM index allows anthropometrists to check the types of degree of accuracy when performing anthropometric measurements:

- **Intra-observer:** when performing and repeating anthropometric measurements.
- **Inter-observer:** when comparing their measurements with measurements by other anthropometrists.

LIPOWISE: WHAT IS NEW

It is generally agreed that assessment with skinfold callipers provides accurate and reliable results. However, traditional callipers, even though accurate if used in the correct manner, were complex to operate and took a long time to perform the localized body composition assessment. These limitations were due in part to the lack of technical evolution.

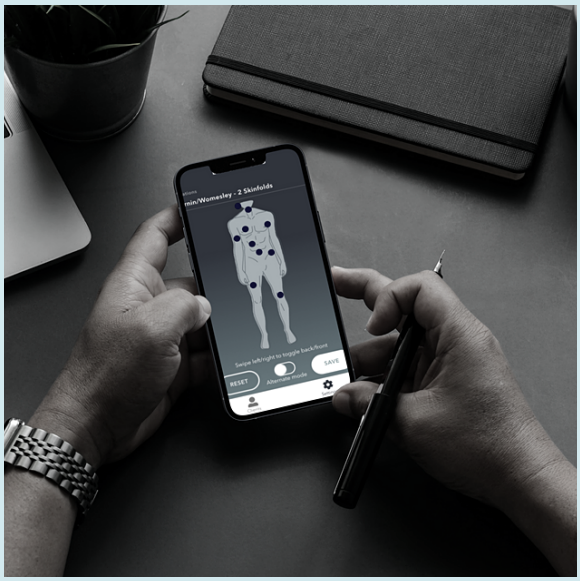
After more than 50 years of skinfold calliper use, a new digital system has emerged at Porto's University: the Lipowise!

Lipowise is an integrated system that comprises a digital skinfold calliper, a mobile APP and a cloud platform.

This new smart calliper reduces measurement error, since it facilitates the complex measurement protocol, eliminates parallax errors, and reduces susceptibility to human error.

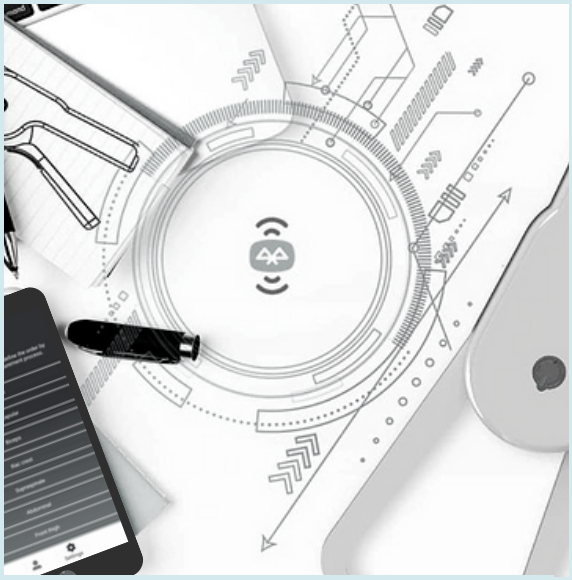
Lipowise brings advantages to body composition assessment using a skinfold calliper and simplifies the whole process to obtain the body fat percentage.

The assessment becomes:



30% FASTER

Simple, automated protocol



20% MORE ACCURATE

Eliminating the need to read an analogic dial

FEATURES OF LIPOWISE

- Constant pressure to the skinfold with an opening of up to **100mm**;
- Recording of the skinfold thickness after a **pre-defined**, configurable period of time;
- Possibility of visualizing **immediately the errors** between measurements;
- Lipowise measures skinfold thickness **100 times** per second.

Lipowise simplifies body composition assessment by automating most of the process. The examiner only has to mark the anatomical locations and perform the skinfold measurement with the calliper. The data and subsequent calculations to obtain the BF% are done automatically.

In addition, Lipowise has an associated cloud where all the data is stored and it is possible to export all the pseudo anonymised results recorded in the application to a CSV file. Thus, all the data can be easily analyzed.

COMPRESSIBILITY OF TISSUES

The introduction of Lipowise brought the possibility that, in addition to assessing the thickness of skinfolds, we can obtain information about the compressibility of the evaluated tissue. By integrating a digital system, Lipowise can take 100 measurements per second, which allows the compressibility graph of the fold to be plotted and the behaviour of the skin tissue to be visualised.

Research has shown that measurements lasting three seconds reveal that the dynamic evolution of tissue compressibility shows very different characteristics among free-living adults. This analysis on the tissue compression pattern, suggests that the skinfold behaviour under compression is like a first response to the constant force applied by the calliper.

Skinfold compressibility varies across body sites and individuals, reflecting differences in skin thickness and tissue pattern.

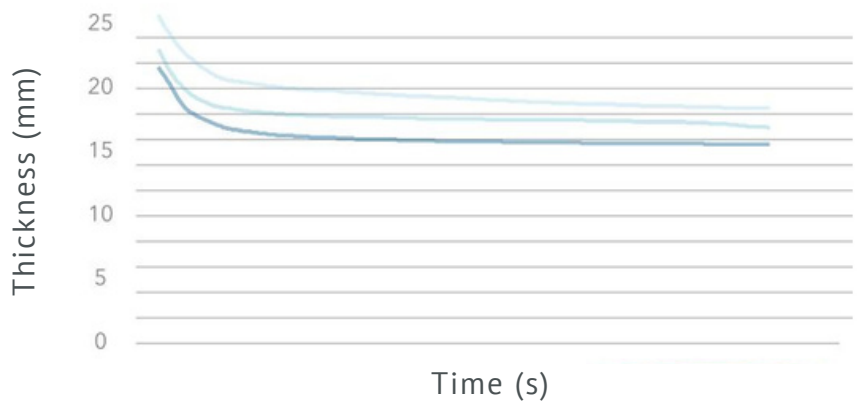
Currently, there is not a large amount of literature on this marker, as there was no method available to evaluate it.

Knowledge of this new marker may have important implications for the study of:

- Hydration status;
- Inflamed body fat;
- Pregnant woman assessment;
- Body fluids in nephrology;
- Beauty treatments.

It is necessary to intensify research on this new marker and open new doors for the scientific matter.

Compressibility



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SKINFOLD THICKNESS MEASUREMENT & ANTHROPOMETRY

If you want to know more, please check:

LIPOWISE