

# i20

Body Composition Analyzer

## Body Composition Result Interpretation



## About this manual

This user's manual is intended as a guide for user's precautions and proper interpretations of analysis results. You should read this manual carefully prior to operation and for more accurate body composition analysis.

## Trademark

The name of the product in this manual may be the trademark or the registered mark of the company.



If you have technical issues or any clinical inquiries, contact the following number.

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# i20 Result Interpretation

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# 1. Precautions

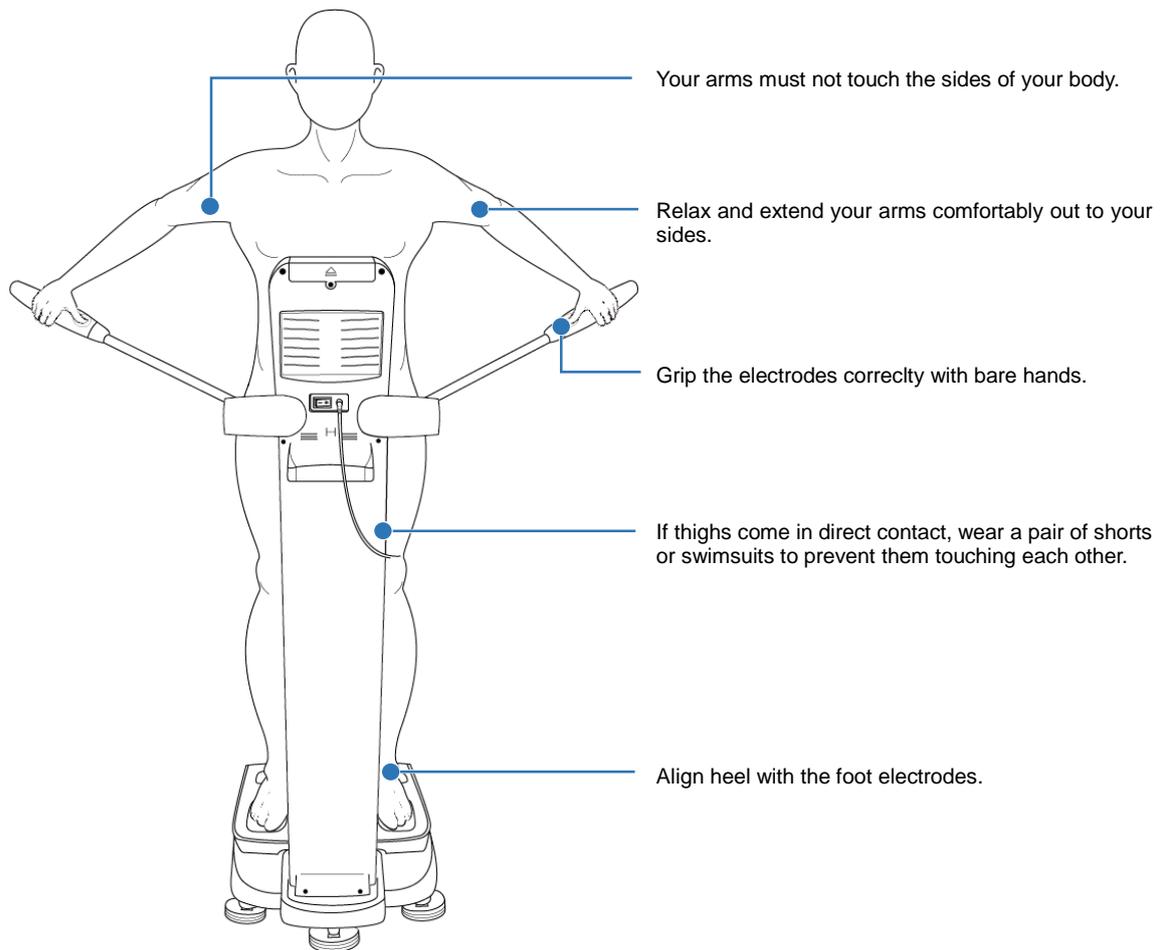
The accuracy of BIA(Bioelectrical Impedance Analysis) varies significantly depending on user conditions (meal, exercise, clothes, drinking, bathing, urination, body temperature, etc.) Therefore, it is advised to remove any misleading factors prior to operation for improved analysis control.

## WARNING

- BIA analysis should be approved by medical experts if you fall into any of the following user groups – pregnant women, or persons who have had surgical operation or ever been clinically diagnosed with any type of disease.
- BIA analysis should be consulted with doctors if you have injuries of either internal or external nature.
- Measurement is prohibited for the examinee with an internally implanted Pacemaker.
  - Measurement should be taken on an empty stomach, as food intake may affect accurate measurement.
  - Measurement should be taken prior to physical activity or exercise. Violent physical movement may cause temporary results change.
  - Measurement should be taken prior to taking a bath. Bathing before measurement may cause slight, temporary change of total body water distribution & total body water percentage.
  - Stand upright for about 3 minutes before you take the test for more reliable results.
  - Excessively high or low body temperature may cause inaccurate measurement control. Human body maintains the most stable condition at normal temperature.
  - Measurement should be taken after excretion or urination. Extra body waste may add up to result figures, resulting in inaccurate analysis.
  - Wear light clothes and take off accessories. Wearing heavy clothes or accessories may cause the problem of adding extra weight on result.
  - Menstruation may cause a temporary increase of body water, which could affect measurement results.
  - If repeated measurements need to be taken over a specific period of time, make sure your tests have been taken under the same conditions for comparison of data results.
  - Dry limbs or excessive callouses may hinder accurate measurement. Wet-wipe palm and sole prior to measurement.
  - Large surgical scars or skin problems may hinder accurate measurement.

## 2. Measuring Posture

Take care of your posture. Incorrect posture may cause inaccurate measurement.



# 3. Result Analysis

ID .	mediana12345	Date.	2019.02.01 09:00
Gender .	Male	Height .	175.0 cm
		Age .	30

### Weight Control

BMI (kg/m<sup>2</sup>) **22.9** (18.5 - 25.0)

Obesity Degree (%) **103.9**

Desirable Weight (kg) **68.5**

Weight Control (kg) **-1.5**

Body Fat Control (kg) **-1.5**

Muscle Control (kg) **0.0**

### Visceral Fat Level

**High**

### Abdominal Fat Ratio

**0.83**

### Intake & Consumed Calories

BMR (kcal) **1623**

Total Energy Expenditure (kcal) **2434**

### Impedance

kHz	LA	RA	TR	LL	RL
10	318.4	319.5	26.8	243.1	248.2
100	272.3	272.7	20.5	208.7	209.1

### Body Composition History

Date	Weight (kg)	Muscle (kg)	Body Fat (%)
'18.09.01	68.1	52.1	19.3
'18.10.01	68.0	52.6	18.5
'18.11.01	75.0	54.0	19.1
'18.12.01	69.7	53.2	18.9
'19.01.01	73.0	54.5	19.0
'19.02.01	70.0	55.8	17.1

### Body Composition Analysis

	Total Body Water (L)	Protein (kg)	Mineral (kg)	Body Fat (kg)
Values (Standard)	<b>45.7</b> (35.3 - 47.6)	<b>9.5</b> (9.5 - 12.9)	<b>2.80</b> (3.37 - 4.56)	<b>12.0</b> (6.7 - 13.5)
Total Body Water (L)	<b>45.7</b> (37.3 - 46.4)	<b>55.8</b> (50.9 - 57.3)		
Muscle Mass (kg)				
Fat Free Mass (kg)			<b>58.0</b> (53.9 - 60.6)	
Weight (kg)				<b>70.0</b> (56.7 - 76.6)

### Muscle & Body Fat Analysis

	Under	Standard	Over
Weight (kg)	36.8 46.7 56.7	66.6 76.6 86.5	96.5 106.4 116.4 126.3 136.3
Muscle Mass (kg)	44.6 47.8 50.9	54.1 57.3 60.5	63.7 66.9 70.0 73.2 76.4
Body Fat Percentage (%)	0.0 5.0 10.0 15.0	20.0 25.0 30.0 35.0	40.0 45.0 50.0

### Segmental Analysis & Body Balance

Muscle

Body Fat

Body Balance

"Please refer to the manufacturer's manual for explanation of measurement results or Contact your administrator"

Memo

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### 3.1. Personal information

On the top right of your analysis results sheet, you can find the date of measurement, and personal information such as ID, gender, height and age.

ID .	<b>mediana12345</b>	Date.	<b>2019.02.01 09:00</b>		
Gender .	<b>Male</b>	Height .	<b>175.0 cm</b>	Age .	<b>30</b>

### 3.2. Body composition analysis

Human body consists of four major components – body water, protein, body fat and minerals, comprising total body weight. Human body composition varies with age, gender, and personal body traits. You need to make sure each component is in proper balance, as it tells much about your current health condition. See below for reference the standard range of adult body composition.

As for child analysis, a different set of standards is recommended to use, as children's analysis results are highly subject to change during growth period

	Total Body Water (L)	Protein (kg)	Mineral (kg)	Body Fat (kg)
Values (Standard)	<b>45.7</b> (35.3 - 47.6)	<b>9.5</b> (9.5 - 12.9)	<b>2.80</b> (3.37 - 4.56)	<b>12.0</b> (6.7- 13.5)
Total Body Water (L)	<b>45.7</b> (37.3 - 46.4)	<b>55.8</b> (50.9 - 57.3)		
Muscle Mass (kg)				
Fat Free Mass (kg)			<b>58.0</b> (53.9 - 60.6)	
Weight (kg)				<b>70.0</b> (56.7 - 76.6)

## A. Weight

Total body weight is the sum of every body component value put together, and your standard range & value of body weight is calculated as in the following formula.

$$\text{Standard weight(kg)} = \text{Height(m)}^2 * \text{BMI standard value}$$

(Calculation Examples of Standard Weight)

- Standard weight of a male tester of 170.0 cm high =  $(1.7)^2 * 22.0 = 63.6\text{kg}$
- Standard weight of a female tester of 165.0 cm high =  $(1.65)^2 * 21.5 = 58.5\text{kg}$

[BMI Standard Range]

	BMI Standard Range(kg/m <sup>2</sup> )	BMI Standard Value(kg/m <sup>2</sup> )
Westerner(Default)	18.5 ~ 25.0	Male 22.0, Female 21.5
Asian	18.5 ~ 23.0	Male 22.0, Female 21.0

\* Ref. WHO/IASO/IOTF.(2000) The Asia-Pacific perspective: redefining obesity and its treatment. Health communications Australia: Melbourne.

\* The chart above is for adult use. Pre-teen children analysis requires another set of standards.

\* Standard value and range of BMI are able to be changed in the device setting.

## B. Body water

Body water takes up the largest share of body composition, carries oxygen and essential nutrition to cells, and removes waste materials out of the body. Even a minor loss of 20% of body water could cause a serious death risk. Therefore, it is vital to keep your body constantly hydrated for proper body functioning. The standard range of body water is calculated considering the proportion of current total body water percentage compared to standard weight.

\* Ref. Nello et al.(1945) The Body Water and Chemically combined nitrogen content in relation to fat content.

### C. Protein

Protein is one of the essential components of body composition, and is primarily used for formation of bone and muscle tissues, and even takes its part on the immune system and blood clotting. If your body ever seriously notices approaching dangers of nutritional deficiency, then protein would as soon start to “fuel” itself as an alternative energy source to keep the body running on. Therefore, to prevent protein from taking its toll on your health, it is advised to make appropriate diet and exercise plans.

Considerable loss of protein in cancer patients, individuals with chronic disease or old people provides a clinically meaningful glimpse that their muscle is being “fueled” as an energy source to sustain their function on.

\* Ref. Siri W.E.(1961)Body composition from fluid spaces and density\_Analysis of methods.

### D. Minerals

Human body consists of 5~6% of mineral. Minerals are essential for performing many different functions – from building bones, dental health and to maintaining hormonal circulation. Broadly speaking, minerals fall into two types: osseous and non-osseous. Osseous minerals are used for bone and tooth development. Non-osseous minerals are contained in total body fluid or muscle surrounding cells of the body, and are used to maintain main body functions, such as blood clotting, muscle contraction / relaxation.

Minerals are for the majority (82%) osseous, serving as a reliable indicator of bone density. Lack of minerals then debilitates skeletal function for support of the body, becoming all the more serious for senior or female patients who are under the effect of menopause, and highly prone to osteoporosis. The standard range of minerals is calculated through your standard mineral value against standard weight.

\* Ref. Siri W.E.(1961)Body composition from fluid spaces and density\_Analysis of methods.

## E. Body Fat

Body fat mass refers to how much share is taken by body fat in total weight. Body fat is essential in body composition, and it falls into two types: essential fat & storage fat. Storage fat is mostly found over the subcutaneous layer of skin or around the stomach area, in order to protect internal organs from impact, or to reserve energy for later use. Essential fat is vital for survival and reproduction, and is found in a variety of important human organs, such as brain marrow, heart, lungs, liver, kidneys, muscle, or brain.

The standard range of body fat can be calculated through the standard body fat percentage against standard weight.

$$\text{Standard range of body fat (kg)} = \text{Standard weight(kg)} * \text{Minimum standard fat percentage} \sim \text{Standard weight(kg)} * \text{Maximum standard fat percentage}$$

Body fat does a lot of jobs, serving as a warehouse tank for surplus energy stock, used for body protection, normal body temperature, even to generate cell membranes as well. However, unlike every other body component that would eventually find its way out of the body, body fat typically persists to create obesity issues. Therefore, it is recommended to keep within the standard range of body fat.

## F. Body Fat Percentage

It refers to the proportion of body fat mass against total weight, and measured as in the following formula

$$\text{Body Fat Percentage} = \text{Body Fat Mass(kg)} / \text{Weight(kg)} * 100$$

[Standard Range of Body Fat Percentage]

	Asian	Westerner
Male	10 ~ 20%	10 ~ 20%
Female	18 ~ 28%	20 ~ 30%

\* Ref. Lohman et al.(1997) Body fat measurement goes high-tech: Not all are created equal, ACSM's Health & Fitness Journal

\* The above chart is for adult reference. A different set of standards should be used for pre-teen reference.

\* Senior examinees may find themselves to have excessive body fat on adult standards, so need to adjust the standard range a bit higher for accurate analysis following the instructions of clinical experts.

[Standard Range of Body Fat Percentage of Children]

Gender	Age	Standard range of body fat percentage	Standard value of body fat percentage	
Male	3	12 ~ 22	17	
	4	11 ~ 21	16	
	5	9 ~ 19	15	
	6	9 ~ 19	14	
	7	8 ~ 18	13	
	8	8 ~ 18	13	
	9	8 ~ 18	13	
	10	8 ~ 18	13	
	11	8 ~ 18	13	
	12	9 ~ 19	14	
	13	9 ~ 19	14	
	14	10 ~ 20	15	
	15	10 ~ 20	15	
	16	10 ~ 20	15	
	17	11 ~ 21	16	
	18	10 ~ 20	16	
	Female	3	13 ~ 23	19
		4	12 ~ 22	17
5		11 ~ 21	17	
6		11 ~ 21	16	
7		12 ~ 22	17	
8		13 ~ 23	17	
9		14 ~ 24	18	
10		15 ~ 25	20	
11		17 ~ 27	21	
12		18 ~ 28	22	
13		19 ~ 29	23	
14		20 ~ 30	25	
15		21 ~ 31	26	
16		21 ~ 31	26	
17		22 ~ 32	27	
18		22 ~ 32	27	

\* Ref. Fomon, S. J., Haschke, F., Ziegler, E. E., & Nelson, S. E. (1982) Body composition of reference children from birth to age 10 years. The American journal of clinical nutrition, 35(5), 1169-1175

## G. Fat Free Mass

Fat Free Mass refers to the rest of body composition “minus” total body fat. The standard range of fat free mass is calculated through the standard percentage of fat free percentage against standard weight.

$$\text{Standard range of fat free mass(kg)} = \text{Standard weight(kg)} * \text{Minimum standard fat free percentage} \sim \text{Standard weight(kg)} * \text{Maximum standard fat free percentage}$$

[Standard Range of Fat Free Percentage]

	Asian	Westerner
Male	80 ~ 90%	80 ~ 90%
Female	72 ~ 82%	70 ~ 80%

\* Ref. Lohman et al.(1997) Body fat measurement goes high-tech: Not all are created equal, ACSM's Health & Fitness Journal

## H. Muscle Mass

Muscle control is initiated by the nerve system to produce physical movement. Broadly speaking, there are three types of muscle – skeletal muscle for producing movement, cardiac muscle for heart operation, and visceral muscle for the digestive and intestinal system. But, segmental analysis of each three type of muscle is not measurable using BIA. MEDIANA's body composition analyzer, **I20**, represents muscle mass by summing up the mass of all three muscle types.

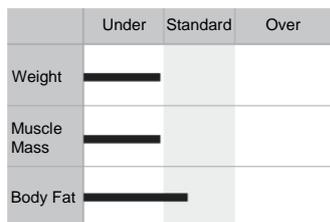
\* Some analyzers represent skeletal muscle mass by only 'mathematically' summing up total muscle mass from given data.

Extreme weight loss may cause muscle loss, so proper exercise regime needs to be followed with proper diet plans. Human body consists of 65~85% of muscle, and standard range of muscle mass is calculated through standard muscle percentage against standard weight.

### 3.3. Muscle & Fat analysis

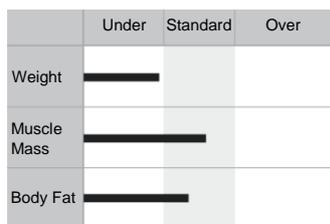
Weight scale is an easy way to measure obesity. However, even if you have low body fat, people with a lot of muscle can be assessed as obese, because the weight exceeds the standard range, so weight alone cannot accurately determine obesity. Therefore, in order to properly assess obesity, body fat percentage should be checked, which is the percentage of body fat in weight.

#### ○ Example of Muscle & Fat analysis



#### [Underweight Weak]

Both of your body weight and muscle mass fall far below standard. You need to gain weight by managing muscle mass, carefully controlling excessive body fat.



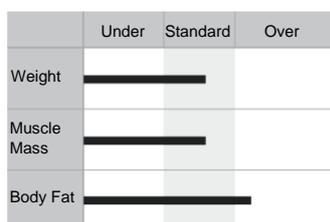
#### [Underweight Muscular]

Even though your total weight is below standard, your muscle mass still belongs to the standard zone, making you stay in muscular shape. If your fat mass level stays extremely low, you need to track your weight changes, so you would not lose more body fat. Extremely low fat mass may affect your immune system, resulting in chronic fatigue and hormonal changes.



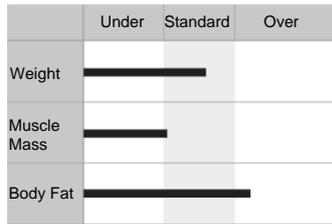
#### [Standard]

Weight, muscle, body fat are all in proper balance. Constant management is needed.



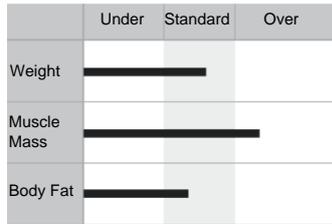
#### [Standard Weight Obese]

Your weight and muscle are safely in the standard zone, only a little bit out of balance on your body fat. It may look normal, but excessive fat can cause health risks. So you may need to lose fat.



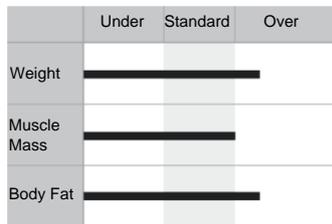
[Standard Weight Weak]

Your weight and muscle mass is standard, body fat being out of balance. Your physical performance presumably could have been affected by lack of muscle, so you need to gain strength through muscle development.



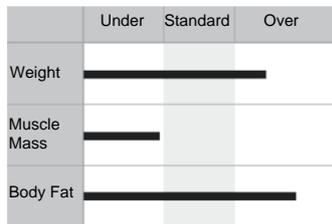
[Standard Weight Muscular]

Your weight safely sits on the standard zone; you are defined as muscular for your massive muscle bulk and controlled body fat. Being desirable in body frame, you only need constant management and care.



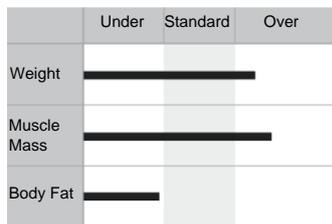
[Overweight Obese]

You are defined as obese: both of your weight and fat mass have got past the standard zone, with your muscle mass hanging at the edge of standard. This body type is mostly found in highly obese groups. You need to reduce your body fat level while maintaining your muscle mass.



[Overweight Weak]

Both body weight and fat are far above standard, while muscle mass falls far behind the standard zone. Due to lack of muscle mass compared to weight and fat, physical ability is below the standard level. Therefore, you need to gain strength through muscle development. You may also need to reduce total body fat to prevent obesity-related issues.



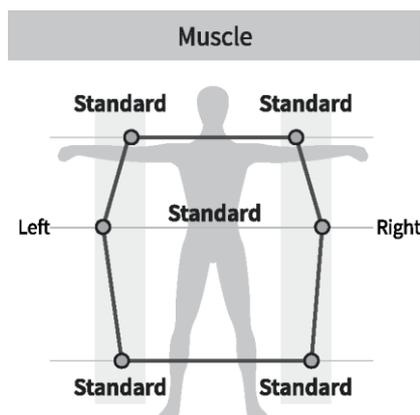
[Overweight Muscular]

You can be defined as athletic in your body frame: muscle mass above the standard and body fat kept under strict control at low levels. Your weight exceeding standard is because of your total muscle mass. Therefore, from a “purely body analytical” perspective, no extra effort to lose weight is required.

## 3.4. Segmental Analysis & Body Balance

### A. Segmental Muscle Evaluation

In segmental muscle evaluation, it gives analysis results for each separate body limb and trunk muscle mass composition to check the development of muscle balance.

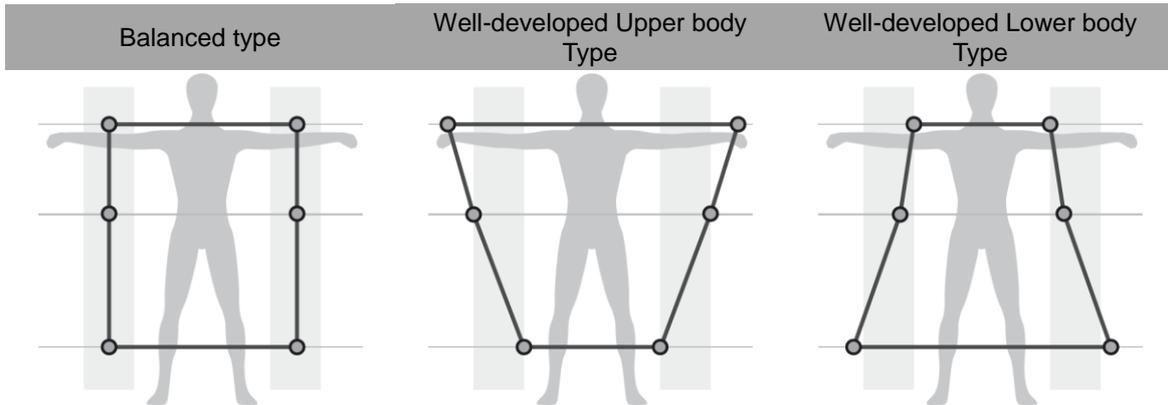


#### 1) Segmental Muscle Evaluation

Segmental muscle mass indicates how well developed every section of your body muscle is in comparison to the standard range. Your analysis results fall within one of either category of “Under”, “Standard”, or “Over” according to muscle development of each section.

#### 2) Segmental Muscle mass Graph

Segmental muscle mass graphs grow outwards from the center of your body with increasing muscle mass. Trunk section is measured as a whole symmetrical cylinder, since trunk part has no specific need for left / right differentiation. In addition, your analysis results are presented with graphs over the shaded zone, allowing you to intuitively compare current status. It will define you as well balanced, if the six dots at every end of each indicator form a rectangular shape, while staying within the standard range.

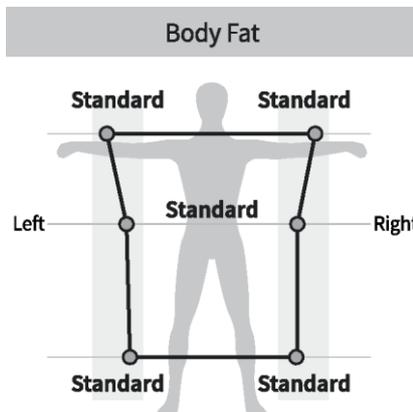


Standard range of segmental muscle mass is based on DEXA data of NHANES(The National Health and Nutrition Examination Survey) from CDC(Centers for Disease Control and Prevention).

Muscle imbalance caused by poor posture habits may lead to malformed body shape, or affected sense of balance. Therefore, it is necessary to track changes of your segmental muscle balance through constant analysis.

## B. Segmental Fat Evaluation

In segmental fat Evaluation, it gives analysis results for each separate body limb and trunk fat composition, enabling fat distribution analysis.

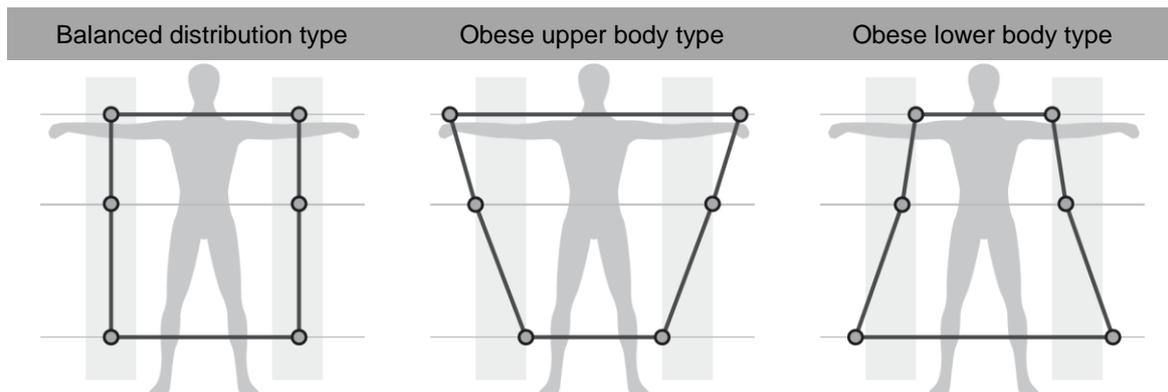


### 1) Segmental Fat evaluation

Segmental fat mass serves as an indicator of body fat distribution in comparison to the standard range. Analysis results fall within one of either category of "Under", "standard", or "Over" according to fat distribution of each body section.

## 2) Segmental Fat mass Graph

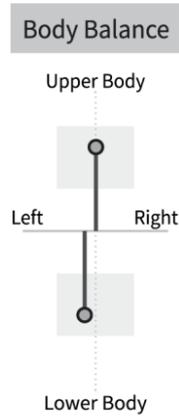
Segmental fat mass graphs grow outwards from the center of body with increasing fat mass. Trunk section is measured as a whole symmetrical cylinder, because trunk part has no specific need for left / right differentiation. In addition, analysis results are presented with graphs over the shaded zone, allowing you to intuitively compare your current status. It will define you as well balanced, if the six dots at every end of each indicator form a rectangular shape, while successfully staying within the standard range.



The standard percentage of segmental body fat mass is a standard value statistically calculated through DEXA data of the Korea National Health and Nutrition Examination Survey conducted by KCDC(Korea Centers for Disease Control and Prevention).

Identical body fat mass of two subjects does not necessarily suggest their body type is “equally identical” as well. Let’s suppose one of them has ‘above-the-standard-fat-level’ legs. His legs would appear much bigger than those of the other guy’s, even though they “statistically” do share the same body type. Likewise, if you have fatter arms, you would appear to have a bigger looking torso, even if you are officially standard on body weight.

### C. Body balance assessment



It allows you to intuitively compare your muscle balance in graph form. The tilt of each part of the graph informs which section of muscle would require more workout. If the bar indicators stay “within” the standard range (shaded area), it suggests sufficient muscle balance has been achieved.

Standard muscle mass can be calculated as in the below formula table, and 80 – 120% of muscle mass is defined as “standard”.

	Items	Formula
1	Standard weight	Height(m) <sup>2</sup> * Standard BMI
2	Standard muscle mass	Standard weight * Standard muscle mass percentage
3	Standard muscle mass of upper body	Standard muscle mass * (Standard muscle percentage of left arm + Standard muscle percentage of right arm)
4	Standard muscle mass of lower body	Standard muscle mass * (Standard muscle percentage of left leg + Standard muscle percentage of right leg)

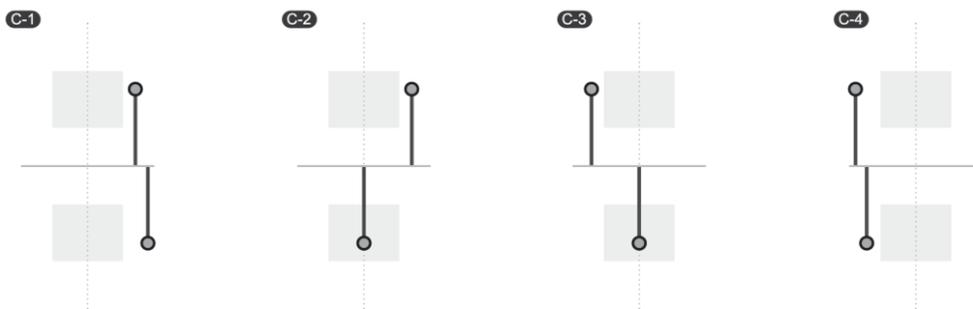
\* The standard percentage of segmental body muscle mass is a standard value statistically calculated through DEXA data of the National Health and Nutrition Examination Survey conducted by CDC(Centers for Disease Control and Prevention).

### ○ Body balance Graph

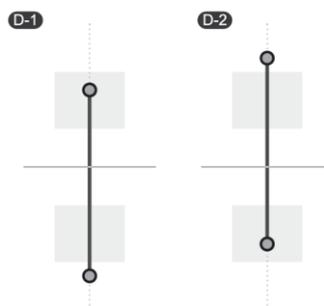


Sides of your body and both of upper / lower parts are all well balanced, with no visible signs of imbalance. You just need to keep up the consistent management.

The arms and legs lack muscle. Upper and lower body parts need training so the balance indicators safely belong into the normal range.

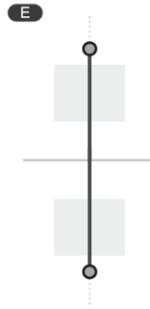


The balance of your upper / lower part of the body has been a little bit pulled aside out of its normal symmetry. After checking which section of limbs has over-grown out of balance, you need to work harder on the opposite part of your affected limbs to get back into normal symmetry.

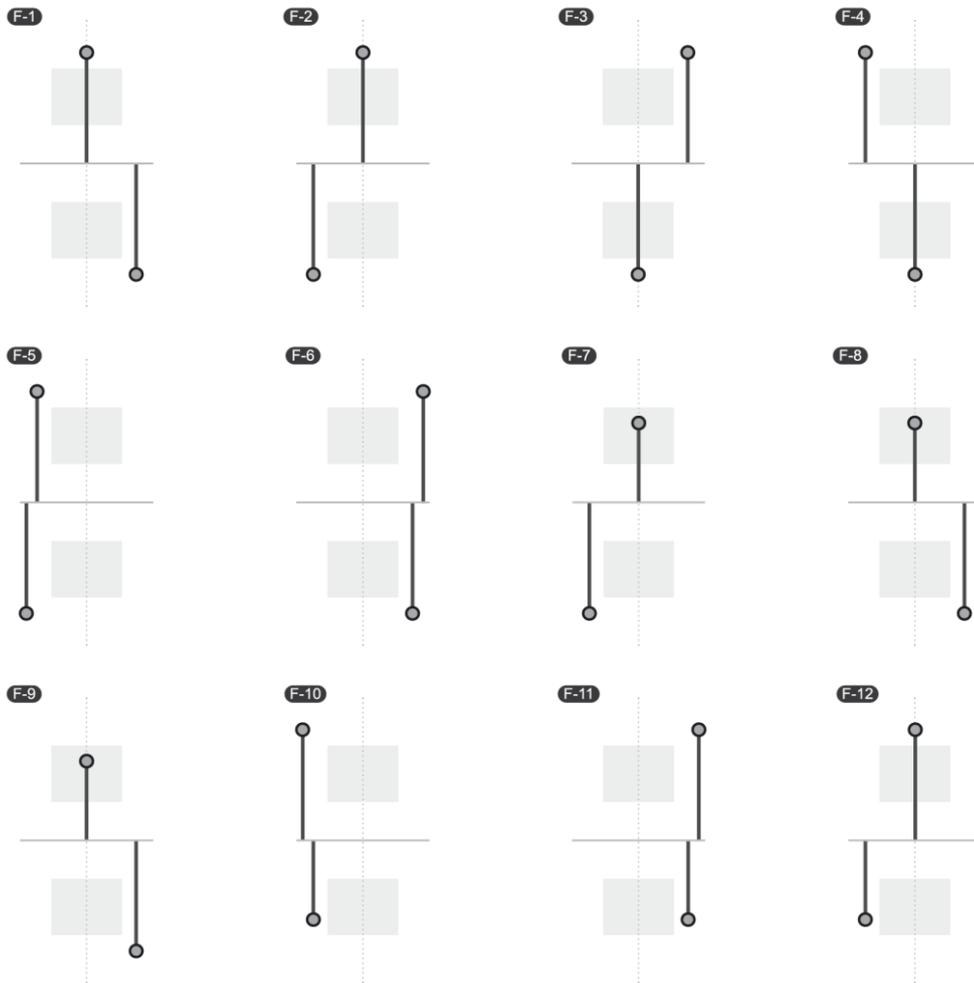


This is typical of individuals who are overly focused on the upper or lower part of their body. It is advised to work on more less-muscled area.

In addition, if you are the type of hard trainer spending too much workout time on building up your legs or torso, you would then need to keep up the balance by working extra hard on the weaker area.



You may look a bit overweight and out of ordinary body proportion. This body type is mostly found in individuals who show a balanced use of both parts of the body. You just need to keep up the balance through constant management.



You may look a bit overweight and out of ordinary body proportion. The balance of your upper / lower part of the body has been a little bit pulled aside out of its normal symmetry. After checking which section of limbs has over-grown out of balance, you need to work harder on the opposite part of your affected limbs to get back into normal symmetry.

## 3.5. Body Composition History

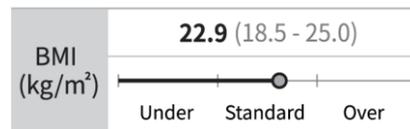
On every measurement, your analysis data is saved to be compared for its transition history.

Date	Weight (kg)	Muscle (kg)	Body Fat (%)
'18.09.01	68.1	52.1	19.3
'18.10.01	68.0	52.6	18.5
'18.11.01	75.0	54.0	19.1
'18.12.01	69.7	53.2	18.9
'19.01.01	73.0	54.5	19.0
'19.02.01	70.0	55.8	17.1

## 3.6. Weight Control

### A. BMI

BMI value can be derived by dividing weight by the square of your height. Even though prevalently used as a simple way to analyze obesity, BMI is limited for its inability to take separate results from subjects of same height and weight – it does not make research on fat mass level. Therefore, body fat measurement should be taken for more accurate obesity analysis.



	BMI Standard Range(kg/m <sup>2</sup> )	BMI Standard Value(kg/m <sup>2</sup> )
Asian	18.5 ~ 23.0	Male 22.0, Female 21.0
Westerner	18.5 ~ 25.0	Male 22.0, Female 21.5

\* Ref. WHO/IASO/IOTF.(2000) The Asia-Pacific perspective: redefining obesity and its treatment. Health communications Australia: Melbourne.

\* The chart above is for adult use. Pre-teen children analysis requires another set of standards.

○ Children standard BMI

Gender	Age	BMI Standard range(kg/m <sup>2</sup> )	BMI Standard value(kg/m <sup>2</sup> )	
Male	3	14.1 ~ 16.8	15.3	
	4	13.8 ~ 16.4	14.9	
	5	13.7 ~ 16.3	14.7	
	6	13.6 ~ 16.4	14.6	
	7	13.5 ~ 16.6	14.7	
	8	13.6 ~ 17.1	14.8	
	9	13.7 ~ 17.6	15.1	
	10	14 ~ 18.2	15.5	
	11	14.3 ~ 18.9	15.9	
	12	14.7 ~ 19.7	16.4	
	13	15.1 ~ 20.4	17.0	
	14	15.7 ~ 21.2	17.6	
	15	16.2 ~ 22	18.3	
	16	16.8 ~ 22.7	18.9	
	17	17.3 ~ 23.4	19.6	
	18	17.9 ~ 24.1	20.2	
	Female	3	14.3 ~ 16.6	15.7
		4	14 ~ 16.2	15.3
5		13.8 ~ 16.1	15.2	
6		13.7 ~ 16.3	15.2	
7		13.8 ~ 16.7	15.5	
8		13.9 ~ 17.3	15.8	
9		14.2 ~ 18	16.3	
10		14.5 ~ 18.7	16.9	
11		14.9 ~ 19.5	17.5	
12		15.4 ~ 20.2	18.1	
13		15.9 ~ 21	18.7	
14		16.4 ~ 21.7	19.4	
15		16.9 ~ 22.3	19.9	
16		17.4 ~ 22.9	20.5	
17		17.8 ~ 23.4	20.9	
18		18.2 ~ 23.8	21.3	

\* Ref. CDC(2000) Clinical Growth Charts

## B. Obesity Degree

Obesity degree refers to the percentage of body weight against the standard range.

Obesity Degree	(%)	<b>103.9</b>
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$$\text{Obesity degree(\%)} = \text{Weight(kg)} / \text{Standard weight(kg)} * 100$$

For BMI, standard range is changeable with variety of age and race, whereas obesity degree has quite a stable value range between 90 – 110%, allowing for easier analysis of body weight.

## C. Desirable weight & adjustments

Desirable weight analysis informs, based on your results, standard weight and how much muscle and fat needs to be gained or lost. Rather than merely being performed statistically – simply through the addition of height and weight of the examinee - Desirable weight analysis carries out “actual” muscle mass analysis for the user.

Desirable Weight	(kg)	<b>68.5</b>
Weight Control	(kg)	<b>-1.5</b>
Body Fat Control	(kg)	<b>-1.5</b>
Soft Lean Control	(kg)	<b>0.0</b>

o **Examples of Desirable weight Calculation**

	Subject A	Subject B	Remarks
Height(cm)	175.0	175.0	
Weight(kg)	73.3	73.3	
Muscle Mass(kg)	50.0	<b>60.0</b>	
Body Fat Mass(kg)	20.1	10.1	
Standard Weight(kg)	67.4	67.4	Male Standard BMI: 22.0 kg/m <sup>2</sup>
Standard Muscle Mass(kg)	54.1	54.1	
Difference from standard	+4.1	-5.9	
Standard Body Fat Mass(kg)	10.1	10.1	Standard fat mass for male: 15.0% of standard weight
Muscle Control(kg)	<b>+4.1</b>	<b>0.0</b>	In case your muscle mass is below standard, it recommends more muscle mass gain. In case you are above-standard, it signals 0 as no such particular effort is required.
Body Fat Control(kg)	-10.0	0.0	
Desirable Weight(kg)	67.4	<b>73.3</b>	If your muscle mass is above standard, it automatically sums that extra muscle mass to your standard weight.

Standard weight is measurable through BMI; you can measure the standard weight of a man of 175.0cm high by applying the BMI value of 22.0kg/m<sup>2</sup>.

$$\text{Standard Weight(kg)} = \text{Height(m)}^2 * \text{Standard BMI} = (1.75)^2 * 22.0 = 67.4 \text{ kg}$$

As you can see from above, BMI is so simple and ready-to-use a way to take a quick look at how to control obesity.

However, conforming a “single” BMI formula to “two” individual subjects of the same height is undoubtedly problematic. Let’s take an example. One of the two subjects (Let’s call him A) is far short of total muscle mass by 4.1 kg from the standard of 54.1kg, even though BMI judges both of the two subjects as “statistically” of identical body type. The other guy (B) has total muscle mass of 60.0kg, far beyond the standard range of 54.1kg. It then would trigger a wrong interpretation that he (B) has to conform his total muscle mass to BMI standard. To prevent possible misinterpretation, excess muscle mass is not counted in desirable weight. Therefore, it is advisable to use desirable weight for more accurate measurement.

### ○ Muscle Control

Heavy muscle bulk facilitates various kinds of internal activity, and helps boost your BMR, thus preventing obesity. Muscle analysis, therefore, lets you see how much muscle gain you should make to make up total muscle mass. On the contrary, if your muscle mass is above standard, it will not turn up any advisory information, just adding that extra muscle mass to standard weight.

### ○ Body Fat Control

Excessive body fat can cause various kinds of metabolic syndrome, while body fat deficiency may seriously affect the immune system, causing chronic fatigue, or hormonal problems. On the other hand, too little body fat can reduce immunity, and cause fatigue and hormonal problems. Therefore, it is recommended to increase the amount of body fat if it is too lower than the standard, and reduce if it is more than standard. However, it should be advised that extreme weight loss over a short period of time will take its toll on your health, especially with following depression, hormonal imbalance, or you may rapidly return to your previous weight again. It's better to consult with medical experts for longer-term diet plans.

#### - Weight Control Guidance Example (Male, Height 170cm)

Measured Weight(kg)	Standard Weight(kg)	Desirable Weight(kg)	Muscle Control(kg)	Body Fat Control(kg)
57.0	63.6	63.6	2.1	4.5

The subject above is standard in his weight and muscle mass, only a little bit below its targeted standard weight, while his fat mass falls far behind. When you find yourself too low in fat mass, it may cause the malfunction of immune system, chronic fatigue, and hormonal imbalance. For this reason, the subject would have to make more muscle & fat gain, each separately by 2.1 and 4.5kg, for more balanced body control.

#### - Weight Control Guidance Example (Male, Height 170cm)

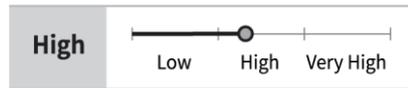
Measured Weight(kg)	Standard Weight(kg)	Desirable Weight(kg)	Muscle Control(kg)	Body Fat Control(kg)
67.4	63.6	66.2	0.0	-1.2

The subject measured above is slightly "overweight" (63.6kg), which is effectively offset by his strictly controlled muscle mass. You do not need to make any extra effort for muscle control; only a bit of fat loss control is required.

\* Muscle mass exceeding standard range does not necessarily need to be kept in control. If it is the case, the amount of muscle mass you need to adjust is shown as 0 kg. Also, the amount of exceeding muscle mass (2.6kg) is then added to desirable weight.

### 3.7. Visceral Fat Level

Visceral fat refers to the accumulation of fat mass around the intraperitoneal mesentery and the aspiration (a wide film hanging from the lower part of the stomach into the abdominal wall) Excessive visceral fat leads to an over-production of insulin, heart attack risks increasing as a natural consequence. Despite being standard on fat mass, you may need to take extra care of abdominal obesity risks, if you have high visceral fat level.



Visceral fat level can be classified based on the width of its surface. It is 100.0 – 119.9 cm<sup>2</sup> wide on “high” level, and more than 120.0 cm<sup>2</sup> wide on “very high” level.

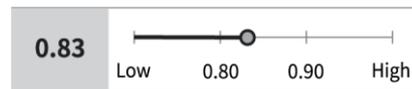
Visceral Fat Level	Visceral Fat Area
Low	99.9cm <sup>2</sup> or less
High	100.0cm <sup>2</sup> ~ 119.9cm <sup>2</sup>
Very High	120.0cm <sup>2</sup> or more

\* Ref. Korean Society for The Study of Obesity.(2001) Clinical Obesity (Second Edition)

\* Ref. JS Hwang, et al.(2005) The Association of Visceral Fat Area with Anthropometric Variables and its Risk for Metabolic Syndrome. Korean Journal of Family Medicine 2005;26:766-773

## 3.8. Abdominal Fat Ratio

Abdominal fat ratio is used to illustrate visceral fat distribution, measuring segmental impedance values of hip and waist circumference.

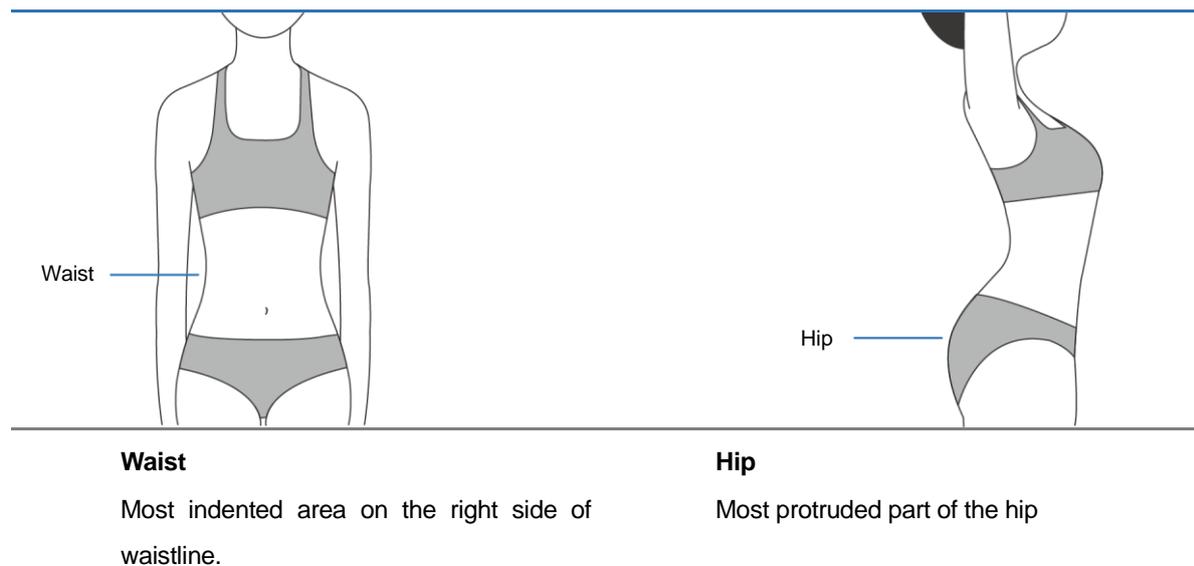


### CAUTION

\* Waist & hip circumference, which is used for measurement of Abdominal Fat Ratio, can be calculated through segmental analysis. The values may vary when taken with a measuring tape.

$$\text{Abdominal Fat Ratio} = \text{Waist circumference} / \text{Hip circumference}$$

The clinical position of waist & hip follows the standard of Size Korea.



According to surveys from WHO(World Health Organization), there are higher risks of metabolic syndrome if abdominal fat rate is above standard. Therefore, even though BMI and body fat mass values are inside the normal range, you are still subject to abdominal obesity risks due to high abdominal fat ratio.

[Abdominal Fat Ratio Standard Range]

	Male	Female
Asian	0.80 ~ 0.90	0.70 ~ 0.80
Westerner	0.80 ~ 0.90	0.75 ~ 0.85

### 3.9. Intake & calorie consumption

#### A. Basal Metabolic Rate

Basal Metabolic Rate refers to the minimum amount of energy required to maintain proper body function and physical homeostasis, and generally means energy consumption at rest with no particular muscle activity

BMR	(kcal)	<b>1623</b>
-----	--------	-------------

Muscle takes up more oxygen than body fat, which means more influence on BMR as a result. So even among people with identical body frame and weight, the difference in BMR inevitably occurs depending on muscle mass. If people are under too strict diet control, it will cause serious muscle loss, resulting in a decrease of BMR, which then also could cause an easier accumulation of body fat. Therefore, even when on diet, it is important to maintain BMR by maintaining muscle mass through proper muscle training.

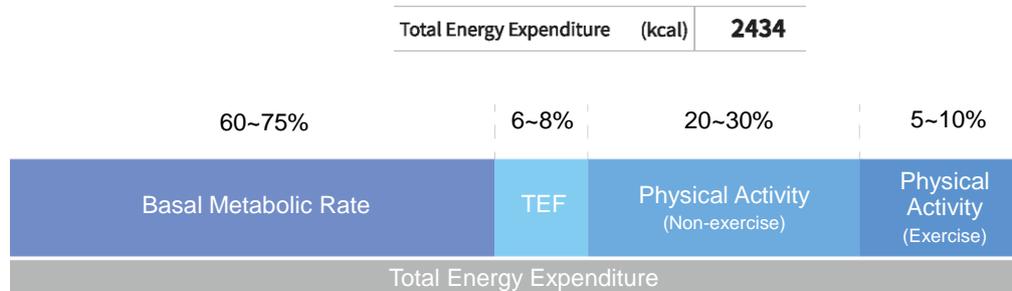
MEDIANA's BMR is calculated using the following formula that adopts fat free mass as a variable to reflect the increase and decrease of muscle mass.

$$REE(kcal) = 370 + 21.6 * Fat Free Mass$$

\* Ref. Cunningham JJ.(1991) Body composition as a determinant of energy expenditure: a synthetic review and a proposed general prediction equation, Am J Clin Nutr. 1991 Dec;54(6):963-9.

## B. Total Energy Expenditure

Energy is essential for survival. In general, energy is used for three purposes: basic metabolic rate, physical activity and Thermic effect of food. Total Energy Expenditure is the sum of energy consumed by these three activities throughout the day.



\* Basal Metabolic Rate: The minimum amount of energy required for proper body functioning

\* Physical Activity: Energy used through everyday activity and exercise, including supporting the body, housework, work performance

\* Thermic Effect of Food(TEF): energy used during the process of digestion.

If specific exercises are performed (1 hour of fast walking 3 times per week) while taking the calories of total energy expenditure, weight can be maintained by balancing energy consumed with energy used. And this balancing process can be referenced for personalized dieting plans.)

## 3.10. Impedance

Impedance is the resistance value that prevents the travelling of electric wave. Because electric wave travels faster on fluid, it is used for analysis of body composition. In addition, varying nature of impedance on different waves of frequency makes possible an accurate, more 'layered' analysis of body composition.

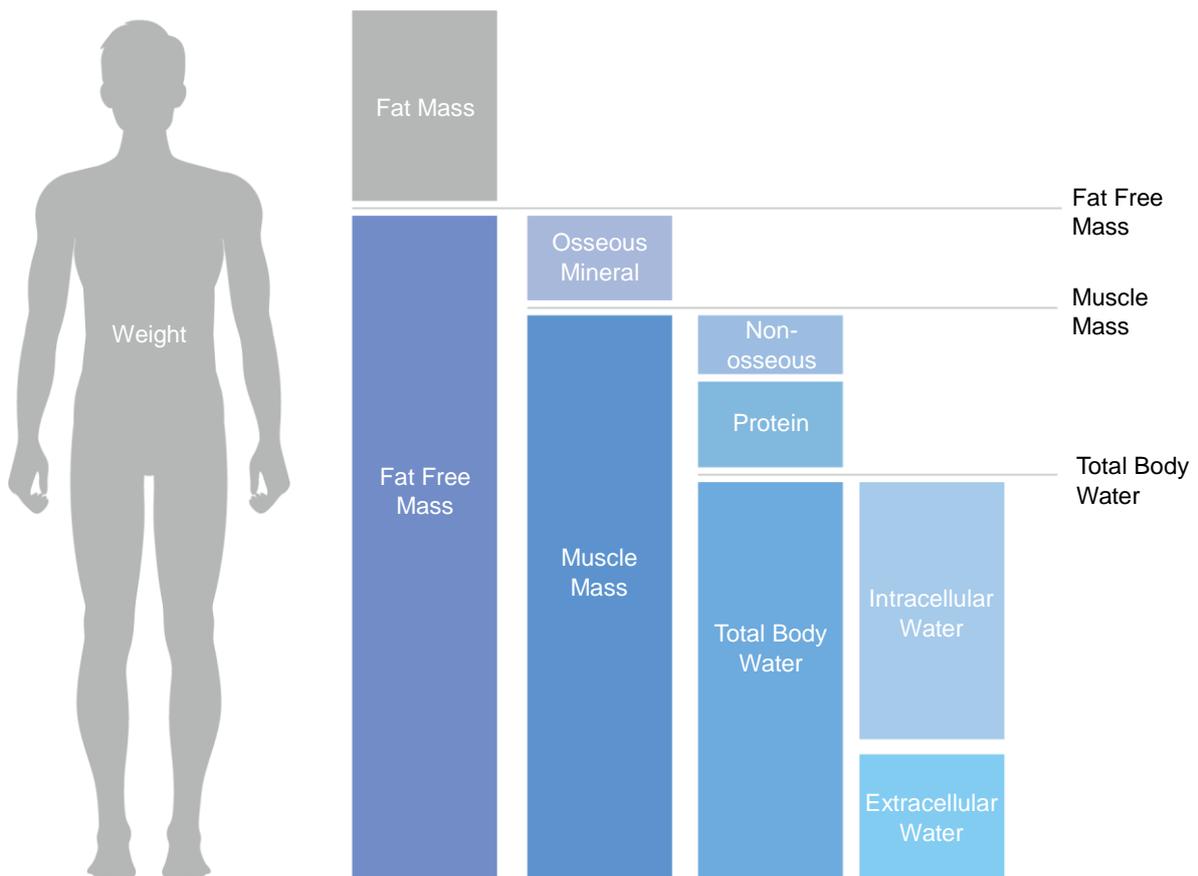
kHz	LA	RA	TR	LL	RL
10	318.4	319.5	26.8	243.1	248.2
100	272.3	272.7	20.5	208.7	209.1

## 4. Body Composition Analysis

Body composition consists of four major components – protein, body water, fat and minerals, all adding up into total weight. Body composition varies greatly with age, gender, and physical traits, and so it has a very strong relationship with health issues. Body composition analysis helps you to see what you are composed of, and to manage your health through proper analysis of accurate body composition. You will be given analysis outputs regarding muscle development, nutritional balance and obesity degree. Body composition analysis provides a variety of clinical insights to consult for the correction of poor eating habits, or for disease prevention – and provides an equally useful basis for establishing diet plans and recovery of patients.

### 4.1. Body Composition Model

See below for body components modeling. You can see weight falling into two categories: fat mass and fat free mass, FFM once again classified into three sub-categories of minerals, protein and body water. They should all be in balanced proportion, and need to be kept in balance to stay in good health.



## 4.2. Body Composition and related symptoms

Healthy people typically succeed in maintaining the standard range of body composition. If the balance breaks down, it may lead to various kinds of disease, or the other way around is also possible.

Obesity issues usually get a fair share of our interest in terms of body composition. According to WHO (World Health Organization), obesity requires more clinical, internal approach, rather than simply considered as being large in outer shape. Obesity is of increasing clinical concern that is more to do with internal issues, such as adult and heart disease, high blood pressure and diabetes. Therefore, clinical discretion is needed to keep body fat percentage under tight control.

Protein is, in nutrition, closely related to one's nutritional status. If nutrients necessary for survival are not taken properly, it may cause nutrition issues in the body. To be specific, muscle cells are broken down to be used as an alternative source of energy, damaging your health. Excessive diet control can also destroy protein and muscle tissues.

A typical symptom associated with mineral issues is osteoporosis, which is very common in women groups experiencing post menopause. Osteoporosis is usually caused by lack of minerals in the bone, and can be determined by a professional bone density meter such as DEXA. Loss of minerals in the bone is also closely related to muscle mass, and maintaining proper muscle mass with proper workout plans can help prevent osteoporosis.

## 4.3. Obesity and body composition analysis

One way to determine obesity is by analyzing the relationship between height and weight, like BMI. This method, based on given information of one's height and weight, has been traditionally adopted as a simpler way to diagnose obesity. But for individuals in certain body types, it can be hard to precisely determine obesity this way only. Let's take for example an athletic gym trainer. He weighs a lot heavier than ordinary people, yet the heavy composition is mostly composed of muscle mass. In this case, it is technically confusing if he is defined as 'overweight'. In addition, elderly people – who are rarely active – may be obese and have a higher risk of body fat issues despite their being thin in external body shape. Since it is nearly impossible to determine how obese a person is at face value, systematic composition analysis is required for accurate analysis results.

## 4.4. Junior and Senior Body Composition Analysis

Teen / Pre-teen examinees go through a lot of variations in body composition as they grow, such as a sudden increase of minerals percentage, or decrease of body water. As a result, if you try to conform children standards into those for adults, you may get wrong results values. Therefore, it is required to perform children composition analysis for teen groups under 19.

On the other hand, bone density and muscle mass of elderly people tend to decrease significantly with age, which also means another significant decrease of FFM such as protein, body water, and minerals.

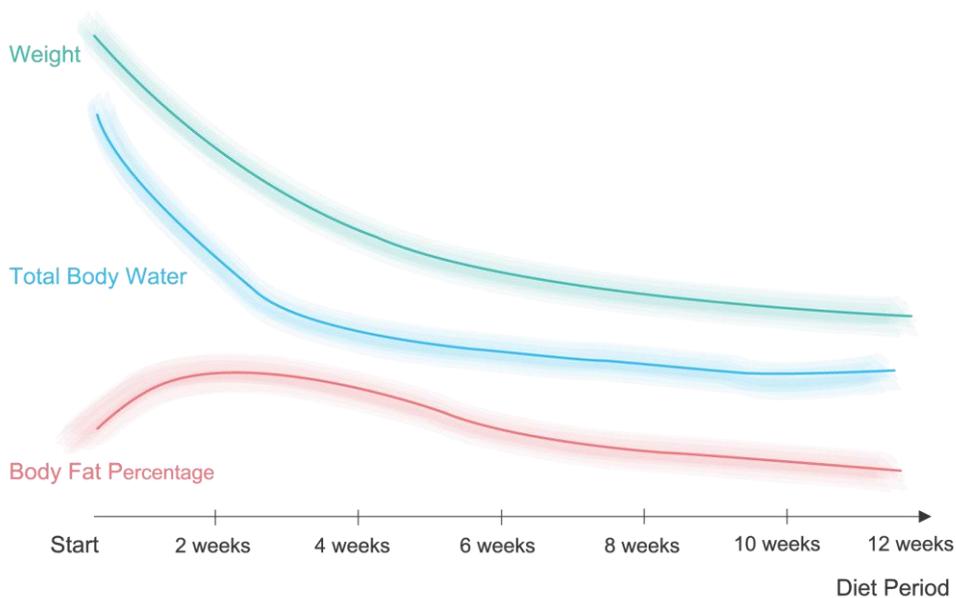
This decrease in FFM leads to weight loss. In this case, even if there seems to be no obvious change in body fat mass, the total body fat increases, because body fat percentage is the ratio of body fat mass to weight. For this reason, muscle mass may be underrepresented, and body fat could be overrepresented, if standards for adult would be applied to senior body composition analysis.

However, aging process is highly individual, so it is difficult to provide personal analysis values for elderly people. Therefore, it is necessary for them to track their changes for more effective composition management.

## 4.5. Weight Loss and Body Compositional Change

The most basic principle of obesity management is to reduce body fat and maintain total weight through constant adjustment of muscle mass. Correlations between diet, exercise, and body composition are already very well documented, so your understanding of how weight loss is actually made is the most important for a successful diet plan.

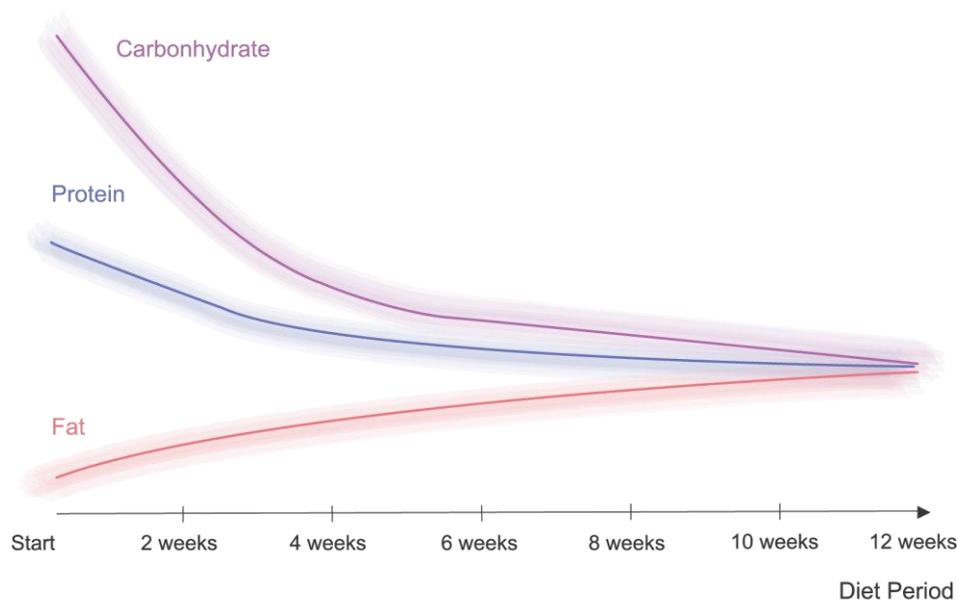
[Body Composition Change Curve]



Carbohydrate is stored in the body being combined with a large amount of water. When you get on a diet, your body quickly begins to divert carbohydrate into an energy source. As a result, at an early stage of your weight loss progress, fluids are lost quickly and you experience actual weight loss. But, despite a very common misconception that you are losing significant body fat during this stage, you would find it simply increasing. This is because you are containing a higher percentage of body water than fat, with fat feeling “relatively” minimal than body water as a result. This would increase the ratio of body fat against total body weight, which then leads to an increase in body fat percentage.

$$\text{Body fat percentage} = \text{Body fat mass} / \text{Weight} * 100$$

[Nutrition Consumption Curve]



After carbohydrate is used up as an energy source, your body then begins to turn to protein as an alternative. However, alternative use of protein for physical operation disables some of beneficial muscle tissues in the body, harming health in general. So, you need to do extra muscle workout in order to cushion the muscle loss. Protein, like carbohydrate, contains a lot of water inside, which helps you lose weight more quickly even at the middle stage of the progress. As you may get closer to the final stages of weight loss plan, your body eventually begins to burn up body fat. Whereas carbohydrate or protein is able to supply 4 kcal by 1g, body fat works in twice higher efficiency of using 9 kcal by 1g. In addition, fat tissues contain less water. So, even though you have successfully had your body fat tissues broken down in sufficient amounts, they release much less water than protein and carbohydrate, - which means equally much less weight loss when added in total sum. But, this is where “actual weight loss” is taking place, making a real body change for your fat percentage. Typical signs of rapid weight loss are seen as a temporary physical reaction to sudden loss of body fluids, so cannot be considered as the process of obesity treatment. If the loss is to become “actually” meaningful towards your weight loss, you need to take a more soft, step-by-step approach to cushion the shock.

## 4.6. Glossary of Confusing terms

### A. Muscle & Skeletal Muscle Mass

Muscle mass is largely composed of three parts - Skeletal Muscle, Cardiac Muscle and Visceral Muscle. Skeletal Muscle refers to muscle parts that support or produce movement of bones, variable through how much muscle workout has been made. For this reason, some other types of body composition analyzers are using “skeletal muscle” as the main analysis indicator, rather than simply going for “muscle” in order to avoid confusion.

However, BIA body composition analyzers basically cannot measure skeletal muscle. Systematic analysis of skeletal muscle goes so far as to not only take segmental impedance measurements and even includes a process of proportional estimation. However, segmental muscles and impedance values bear relatively low correlation, thus accurate analysis controls “hardly” assured.

Therefore, MEDIANA's body composition analyzer, **I20**, adopts “muscle” as the main analysis feature because of its high correlation with impedance values, instead of the feature of “skeletal muscle” that is relatively inaccurate.

### B. Mineral & Bone & Osseous Mineral

Body composition analysis provides analytical results of mineral mass for proper bone health management. Many different confusing terms are presently in use to express body mineral representation such as “bone mass”, or “osseous mineral mass”, “mineral mass”.

First of all, “mineral mass” is a generic term for encompassing every type of minerals in the body, not merely for one making up the bone mass. The term “mineral mass” does not fit perfectly in the strictest sense, but since minerals are for the most part (82%) osseous, you can take a general view of your current bone health.

As for bone mass, it refers to total weight of the bone tissues that contain many different components other than minerals, such as protein or water. Therefore, bone mass might be an incorrect term for precisely expressing bone components.

Finally, “osseous mineral mass” is the most accurate term for expressing the total amount of minerals in our bones. Osseous mineral mass is only measurable through DEXA method among the three frequently confused terms, and is the most suitable indicator for checking your bone health

## 5. Accuracy of body composition analysis

### 5.1. Golden Standard

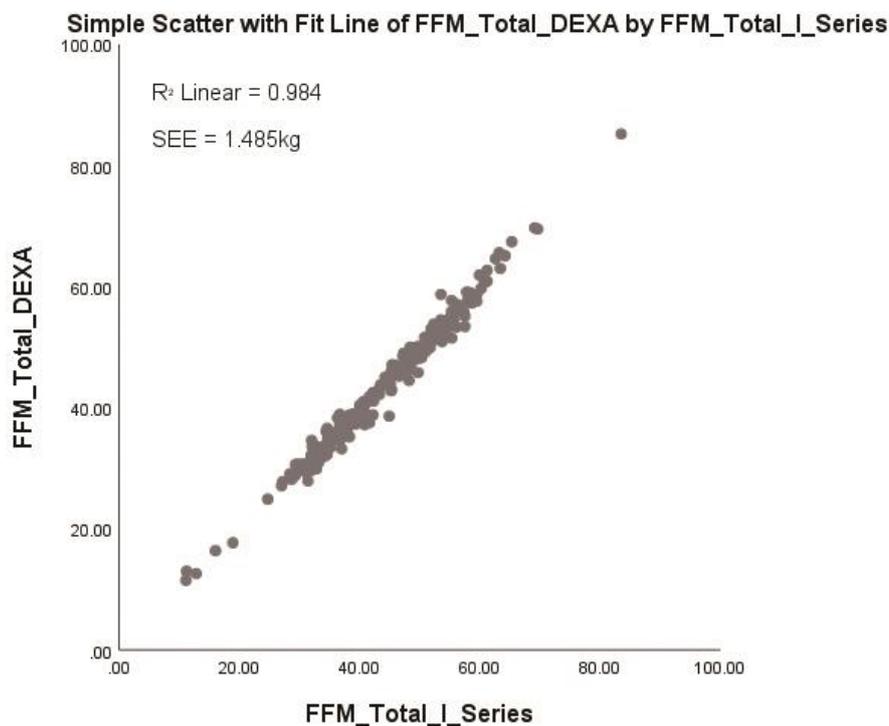
Golden Standard serves best for accurate analysis of body composition, but not cost and time effective

#### ○ DEXA(Dual Energy X-ray Absorptiometry)

DEXA method irradiates human body with X-ray waves of high and low energy. X-ray penetrates through human body, and as it travels in the body, the power and rate at which it runs through the body would be reduced with factors such as body components, density, and thickness.

DEXA method is regarded as Golden Standard, and serves best for accurate analysis of body composition: FFM, body fat mass and muscle mass. DEXA also provides segmental analysis results, thus serving as a perfect barometer for the accuracy of BIA. The result of comparison between DEXA and **I20** is as follows:

#### ○ DEXA vs I Series(FFM)

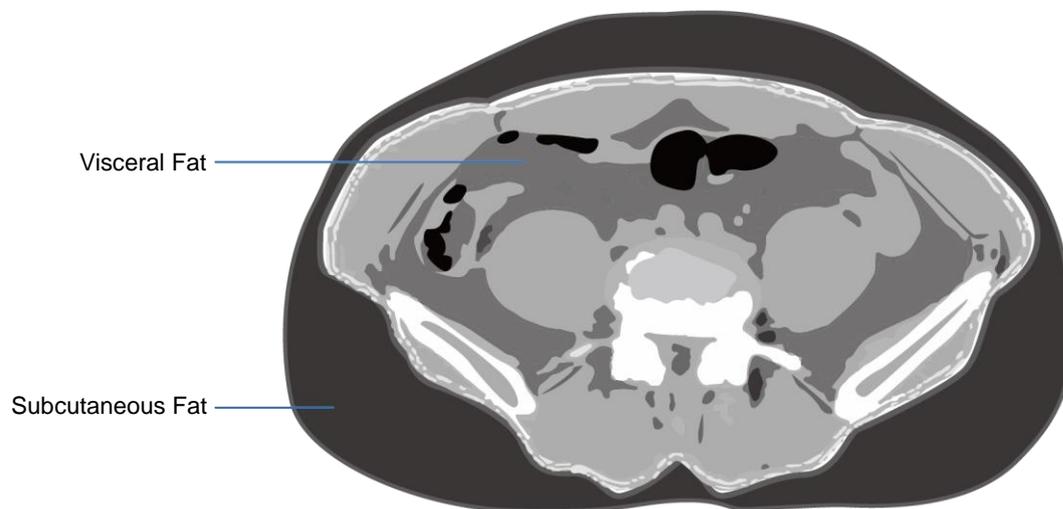


$R^2$  value refers to the credibility of its regressive equation. The more inaccurate results the equipment produces, the closer it gets to 0, and vice versa. Our equipment, **I20**, shows the figure of 0.984 closer to the DEXA standard, which means high accuracy.

○ **CT(Computerized Tomography)**

Visceral fat level of I series body composition analyzer is based on CT clinical test data. CT or computed tomography makes use of many X-ray measurements taken from different angles to produce cross-sectional images of a scanned object. As all sections of human body are different in density, while the radiation passes through internal organs, it has to travel through a wide range of density, which would then be presented in the distinctly graded shade for clear visualization.

CT shows very high accuracy in measurement. But, because of its radiation exposure problems and high cost, its use is strictly limited to segmental analysis of body sections like abdomen. As for abdominal CT, it is able to scan visceral fat area and subcutaneous fat, allowing for accurate abdominal obesity analysis.



○ **Isotope Dilution**

A lot of clinical trial tests for Isotope Dilution have been conducted for I Series body composition analyzer in order to take more accurate body water measurement. Isotope dilution is a method of measuring body water by analyzing the concentration of isotopes. First, clinical trial subjects need to administer isotope which then would evenly spread over the body. Then, sample body fluids are taken from the subjects to check the concentration. Isotope dilution is highly accurate in measurement, but impractical as it takes too much time to test, highly prohibitive, and thus hard to take repeated measurement.

## 5.2. Bioelectrical Impedance Analysis(BIA)

BIA is a method of measuring impedance(resistance) value of the body by sending out several weak waves of electricity through the body. BIA is best known for its high accuracy, reproducibility and convenient usability, especially when considering how cost-effective and convenient it is. It only requires direct electrode contact, and just takes only a few seconds to finish the measurement. It is also non-invasive, safe and easy to use, without you having to give your blood, or get anything inserted into your body. However, BIA value can occasionally vary with one's physical condition or measurement errors, then adding up to a bigger difference. That is why it is necessary to follow correct instructions, and take repeated measurements under the same conditions.

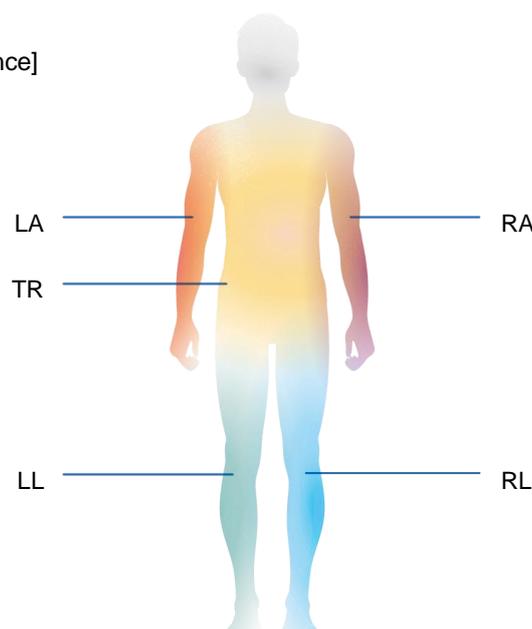
### A. Principles

Bioelectrical Impedance refers to the resistance value that prevents electrical current from flowing freely through the body. As muscle contains higher volumes of water than fat tissue, the current flows much faster. Then, people with large bulk of muscle experience small impedance, whereas individuals with a lot of fat mass suffer from higher impedance. MEDIANA's body composition analyzers, based on this principle, measure impedance for body composition analysis.

### B. Segmental analysis

Segmental Measurement Method measures the impedance of human body, assuming big five cylinders of body segments combine to form a whole single human body. Segmental analysis is able to take more accurate measurement, because it can evenly spread its measuring focus on all body parts, rather than just seeing it as a single piece of cylinder. In particular, it makes possible to make segmented distribution analysis of body fat, muscle mass, and body water for more effective analysis of subjects.

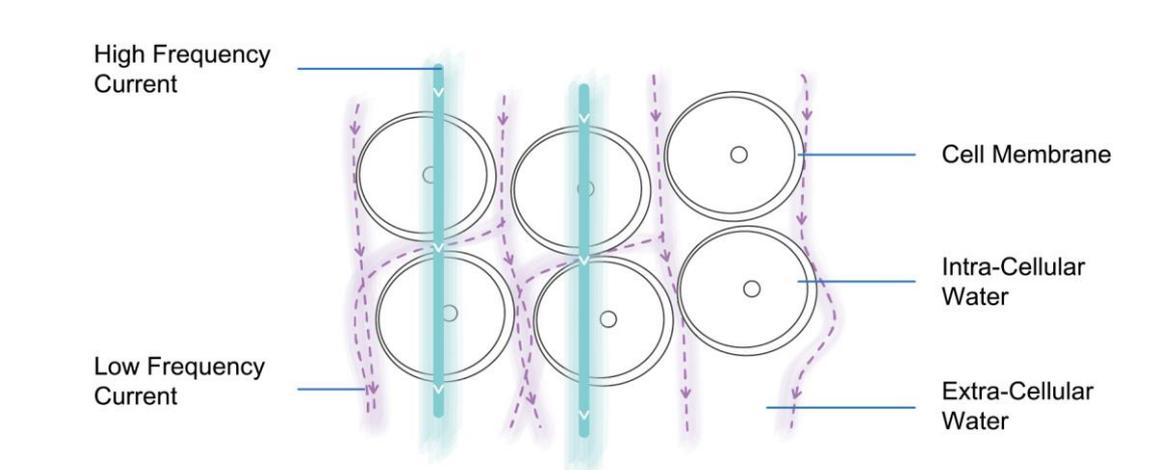
[Division of Segmental Impedance]



### C. Multi-frequency BIA measurement

Cell membranes are nearly impassable to low frequency waves, whereas the travel of high frequency waves is rarely resisted. Therefore, both use of low and high frequency waves makes possible a more separate analysis of body cells. Every length of frequency wave is applied to its designated body areas for improved equation accuracy. Therefore, it is necessary to measure the impedance using a lot different waves of frequency for accurate composition measurement.

I series has high accuracy using multi-frequency method for body composition analysis.







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