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Resting energy expenditure; assessment methods and applications

Raquel Blasco Redondo


Abstract

The energetic expense daily total of an individual (EEDT) represents the energy that the organism consumes. It is constituted by the sum of: metabolic basal rate (MBR), termogenesis endogenous (TE) and energetic expense linked to the physical activity (EEPA).

The determination of the EEDT considering the physical activity and the state of health of a person, it is very important to fit the calculation of the nutritional need for every individual.

The MBR is the minimal quantity of energy that an organism needs to be alive. It constitutes a from 60 to 70 % of the EEPA in the majority of the sedentary adults, while, in the physically very active individuals it is of approximately 50 %. It changes depending on the corporal composition, specially on the corporal lean mass.

The basal metabolism expressed as MBR, it is different from the metabolic rate in rest (MRR) or Resting energy expenditure (REE); the latter is obtained when the determination is done in rest and in the conditions described for the MBR but not in fasting, including therefore the energy used for the biological utilization of the food.

Habitually, the REE decides by means of different technologies as the indirect calorimetry, the electrical bioimpedancy, the doubly marked water, the predictive equations, between others. These methods are used in the clinical practice and in scientific studies. Nevertheless, due to the inconsistency of the results of these researches, still there is no a consensus with regard to his applicability though the evidence indicates that the measurement of the consumption of oxygen, it is the method of major precision.

Aims: This review has as aim expose the components of the energetic expense in rest, as well as the technologies for its determination and estimation, indicating its advantages, limitations and practical applications.

Results: Part of the technologies of evaluation of the energetic expense described in this review, they remain relegated, for its complexity and cost to the area of the investigation. For a long time the indirect calorimetry, she remained also restricted to this field. Nevertheless, the technological advances have allowed the development of precise light and attainable equipments that allow that the technological advances have allowed the development of techniques that allow the technological advances have allowed the development of techniques that allow the technological advances have allowed the development of techniques that allow...

GASTO ENERGÉTICO EN REPOSO; MÉTODOS DE EVALUACIÓN Y APLICACIONES

Resumen

El gasto energético total diario de un individuo (GETD) representa la energía que el organismo consume. Está constituido por la suma de: tasa metabólica basal (TMB), termogénesis endógena (TE) y gasto energético ligado a la actividad física (GEAF).

La determinación del GETD considerando la actividad física y el estado de salud de una persona, es muy importante para ajustar el cálculo de la necesidad nutricional para cada individuo.

La TMB es la mínima cantidad de energía que un organismo requiere para estar vivo. Constituye del 60 al 70% del GETD en la mayoría de los adultos sedentarios, en tanto, en los individuos físicamente muy activos es de aproximadamente el 50%. Varía dependiendo de la composición corporal, especialmente de la masa corporal magra.

El metabolismo basal expresado como TMB, es diferente a la tasa metabólica en reposo (TMR) o Gasto Energético en Reposo (GER); este último se obtiene cuando la determinación se hace en reposo y en las condiciones descritas para la TMB pero no en ayuno, incluyendo por tanto la energía utilizada para el aprovechamiento biológico de los alimentos.

Habitualmente, el GER se determina por medio de diferentes técnicas como la calorimetría indirecta, la bioimpedancia eléctrica, el agua doblemente marcada, las ecuaciones predictivas, entre otras. Estos métodos son utilizados en la práctica clínica y en estudios científicos. Sin embargo, debido a la inconsistencia de los resultados de estas investigaciones, todavía no hay un consenso respecto a su aplicabilidad aunque la evidencia señala que la medición del consumo de oxígeno, es el método de mayor precisión.

Objetivos: Esta revisión tiene como objetivo exponer los componentes del gasto energético en reposo, así como las técnicas para su determinación y estimación, señalando sus ventajas, limitaciones y aplicaciones prácticas.

Resultados: Parte de las técnicas de evaluación del gasto energético descritas en esta revisión, quedan relegadas, por su complejidad y coste al ámbito de la investigación. Durante mucho tiempo la calorimetría indirecta, quedó también restringida a este campo. Sin embargo, los avances tecnológicos han permitido el desarrollo de equipos precisos ligeros y asequibles que permiten que en la actualidad sea un...
at present it should be a very useful method in the clinical space of the determination of the REE.

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Key words: Resting energy expenditure. Methods. Equations. Indirect calorimetry. Applications.

Abbreviations

EEDT: Energetic Expense Daily Total.
REE: Resting Energy Expenditure.
MBR: Metabolic Basal Rate.
ET: Endogenous Thermogenesis.
TEF: Thermal Effect of the food.
EEPA: Energetic Expense linked to the physical activity.
MFF: Mass Free of Fat.
DEXA: Absorciometry of double radiological energy.
CTW: Corporal Total Water.
BIA: Impedance bioelectrica.
EE: Energetic Expense.
PA: Physical Activity.
PAL: Physical Activity Level.
RQ: Respiratory Quotient.
IC: Indirect calorimetry.
DC: Direct Calorimetry.
CF: Cardiac frequency.
VO2: Consumption of Oxygen.
PE: Predictive Equations.

Introduction

In all the aspects of the physiology the balance is looked, the homeostasis. In the field of the energy balance it could not be otherwise.

When we speak about the caloric balance assessment of an organism, this one answers to the dynamic balance between both ends of the following equation:

\[
\text{Energetic contribution} = \text{Energetic expense Total Daily (EETD)} + \text{Energy Excreted} + \text{Energy stored as tissue}
\]

In this contribution we are going to speak about Energetic Expense in Rest, (EER) but before beginning we must define a series of terms:

- The energetic expense daily total of an individual (EETD) represents the energy that the organism (organization) consumes; it is constituted by the sum of:
  1. The metabolic basal rate (MBR) (that is the resultant one of the sum of the energetic expense of the dream (EE of the dream) and the energetic cost of the maintenance of the wake.
  2. The endogenous termogenesis (ET) (that includes the thermal effect of the food (TEF)).
  3. And finally the energetic expense linked to the physical activity (EEPA) (sum of the physical spontaneous activity and of the physical voluntary not restricted activity)

Habitually, the energetic expense in rest (EER) decides by means of predictive equations, but the evidence indicates that the measurement of the consumption of oxygen, it is the method of major precision1,2.

Another determinant of the EER, it is the corporal composition, specially the mass free of fat (MFF); different methods exist (BIA) determines, between them the densitometry, the absorciometry of double radiological energy - DEXA-, the tomography, the measurement of the corporal total water (CTW), the anthropometry and the impedance bioelectrical. The use of the latter has spread so it is not invasive, presents a rapid application, under cost, and safety. Nevertheless, in the practice, the method most used to determine the corporal composition, for its facility of application, under cost, and high precision is the anthropometry, which has been widely validated by others of major precision as the isotopic ones and the densitometrics.

Finally, the endogenous termogenesis (ET) represents near 10% of the EETD and the EEPA represents between 25-75% of the EETD (wide range depending on the physical activity of the individual).

Energetic expense in rest. Definition. Relation with EETD, ET and EEPA

Since already we have seen before, the energetic expense total daily (EETD), it includes the energetic basal expense (EBE), also named metabolic basal rate (MBR), the EETD and ET.

The World Health Organization (WHO), defines the EETD as “the necessary level of energy to support the balance between the consumption and the energetic expense, when the individual presents weight, corporal composition and physical activity compatible with a good state of health, adjustments must be done for individuals by different physiological conditions as growth, gestation, lactation and aging”3,4.
Energetic Expense in Rest. Relation with the metabolic basal rate

The EER is the minimal quantity of energy that an organism needs to be alive and to represent of 60-70% of the total of the energetic expense (EE), in the majority of the sedentary adults, (though along the exhibition we will clarifying these terms).

The EER represents, therefore the integration of the minimal activity of all the fabric of the body in conditions of balance, expresses as production of heat or consumption of oxygen for unit of corporal size. (MET).

A MET is the energetic consumption of an individual in condition (state) of rest, which is equivalent approximately to 1 kcal for kg of weight and hour, that is to say, 4,184 kJ for kg of weight and hour².

Mitchell, defined the EER as the “minimal rate of energetic expense compatible with the life”. He constitutes a from 60 to 70% of the daily EE in the majority of the sedentary adults, while, in the physically very active individuals it is of approximately 50%; it changes depending on the corporal composition, specially on the corporal lean mass⁴.

Margus-Levy in 1899 introduced the term basal metabolism and established that its measurement should carry out in the following conditions:

Patient hold totally rested before and during the measurements, put to bed, in state of wake, in fasting of 10-12 hours, in conditions controlled of temperature (22-26 °C), in absence of infection and free of emotional stress⁵,⁶.

The basal metabolism expressed as MBR, it is different from the metabolic rate in rest (MRR) or from the EER; the latter is obtained when the determination is done in rest and in the conditions described for the MBR but not in fasting, including therefore the energy used for the biological utilization of the food.

Therefore the EER is the taken MBR NOT FASTING

These measurements, they differ in less than 10% and both terms are tended to use indistinctly, though at present there is in use more EER’s name⁷.

There exist several physiological characteristics that do that the EER changes from a few persons to others, principal it are the size, the corporal composition, the age, the sex and the production of hormones⁸.

Energetic expense in Rest. Relation with the Endogenous Thermogenesis (ET) and the thermal effect of the food (TEF)

The energetic cost inherent in the aptitude to regulate the corporal temperature and to keep it stable in environmental unfavorable it represents, in general a small fraction of the energetic total expense. Nevertheless, joined it have to be considered to be also the thermogenesis produced during the processes of diges-

tion, absorption, transport, metabolism and storage of the macronutrients.

The thermal effect of the food (TEF) refers to the increase of the energetic expense (EE) produced after the food consumption, and correspond to the energy necessary for the digestion, absorption, transport, metabolism and storage of the macronutrients.

The intensity and the duration of TEF are determined by the quantity and composition of the emaciated food.

The increase in the EE changes of 5-10% for carbohydrates, 0-5% for fats, and of 20-30% for proteins. The consumption of a mixed diet produces an increase in the EE equivalent to 10% of the energy contained in the food⁹.

Both components of TEF are the obligatory thermogenesis and the physician. The first one is modulated by factors as the activity of the nervous sympathetic system and the tolerance to the glucose; it represents both third parts of the thermal effect of the food.

The optional component TEF corresponds to the third part of and is related to the cephalic phases and postprandial of the (food); In fact has been suggested the need to distinguish between the effects in the short and long term of the (food), choosing the term of thermogenesis postprandial to refer at the hours following the food ingestion and reserving the term “thermogenesis induced by the (food)” only to designate the long-term component, which depends on the effect supported of the level ingestion above or below the energetic needs.

This optional component presents a major activity in some tissues as the skeletal muscle due to the activation of the nervous sympathetic system and of the recipients Beta adrenergic receptors, which stimulate the cellular metabolism¹⁰,¹¹.

III Energetic Expense in Rest. Relation with the EEPA

The Expense tied to the physical activity (EEPA) can subdivide in turn in:

- An energetic expense destined to support the physical spontaneous needs that it seems to be a notably family feature.
- An expense derived from the physical voluntary activity, determined principally by the intensity and the duration of the realized activity and by the own corporal weight of the individual.

In fact, this classification is in conformity with the realized one for The FAO-WHO-UNU (2001¹²) who consider two types of physical activity (PA): the obligatory activities related to the work, the study and the attention of the home and the discretionary activities referred to the physical regular activity, the recreation and the social interaction, considered important because they support the health, provide well-being and improve the quality of life.
The EEPA changes between 25 and 75% of the EEDT. The period of life of major sudden decrease of the EEPA is between the adolescence and the young adult. During this stage, the total activity (minutes/week) and the time of recreative habitual activity (MET/week) diminish strongly in men (31%) and in women (83%). The studies of EEPA and of EEDT during this period reflect important changes in the habits of life, demographic, social and biological, factors that can be associated with an increase of the risk of obesity and of comorbidities13.

The EEPA is very variable between individuals and can change day after day. In sedentary persons, near two third parts of the EEDT they use in the basal metabolism, whereas only a third part becomes exhausted in EEPA. In very active individuals, the EEDT can rise up to the double of the MBR; the expense can be still major in some athletes and in whom they realize heavy duty.

The level of physical activity (PAL Physical Activity Level) is described as the proportion between the EEDT and the MBR and is used to determine the quantity and intensity of the habitual PA of an individual13. 

Until a few years ago the EEDT it was the expense most difficult to determine. At present, the utilization of stable isotopes allows to study the energetic daily expense in habitual living conditions and during long periods of time, from which and in combination with other methods, it is possible to deduce the compartment tied to the physical activity.

If they do not arrange of these analytical methods, there exist diverse tables that allow to estimate a value of energetic expense for different physical activities12.

### Energetic expense in Rest. Measurement.
#### Conditions

The GER can be estimated or measured; the measurement is more precise than the estimation, always and when there are controlled the factors that can introduce modifications, since it are the energy induced by the (food), the consumption of alcohol, the use of nicotine, the PA, the environmental temperature, the position of the individual during the test and the time of measurement.

The recommendations established by the Dietitians’ American Association to improve the precision of this measurement appear in the table I (taken of14).

### Energetic expense in Rest. Technologies(skills) and methods of Measurement

The components of the EE, that is to say the basal metabolism and the expense that any PA needs, can decide for calorimetry, which can be direct or indirect7. Besides the calorimetry, other methods exist to determine the EER and the requirement of energy: the predictive equations, the impedance bioelectrical and the doubly marked water1.

#### The following ones are the most used methods:

- **Direct Calorimetry**

The EEDT can decide for the measurement of the heat quantity produced by the organism. This procedu-
Indirect Calorimetry

Under the supposition of which the chemical energy of a substratum is obtained in the organism (organization) after its complete oxidation by the consequent consumption of oxygen and liberation of carbon dioxide and water, it is possible to estimate the quantity of total heat produced in the organism from the determination of the volume of both gases.

Nevertheless, though this supposition is true for the carbohydrates and the fats, it is not fulfilled for the proteins.

During the processes of multifaceted oxidation the nitrogenous fraction does not oxidize completely being eliminated partly in the shape of nitrogen ureico still energetically. Thinking that the nitrogen corresponds (fits) to 16% of a theoretical pool of proteins, is admitted that the urinary loss of 1 gr of nitrogen corresponds (fits) to the energy produced during the oxidation of 6,25 grs of protein.

Therefore, from the measures of the gases emaciated and liberated during the oxidative processes, there can be estimated the energetic basal expense or of rest, in these terms these stocks the indirect calorimetry (IC).

The IC since it is a not invasive method that allows to estimate the production of energy equivalent to the MBR and the rate of oxidation of the energetic substrata. The name of hint indicates that the metabolic expense decides by means of the caloric equivalents of the oxygen (O\textsubscript{2}) emaciated and of the carbon dioxide (CO\textsubscript{2}) produced, whose quantities differ according to the energetic substratum that is being used.

The production of energy corresponds to the conversion of the chemical energy contained in the nutrients in chemical energy stored as ATP and, in the energy removed as heat, during the process of oxidation. If is admitted that the whole emaciated O\textsubscript{2} is in use for oxidizing the energetic substrata (proteins, carbohydrates and lipids) and, that the whole produced CO\textsubscript{2} eliminates for the breathing, is possible to calculate the total energy produced by the nutrients\textsuperscript{1}.

The IC is based on the principle of the gas exchange: the breathing in a calorimeter produces depletion of O\textsubscript{2} and accumulation of CO\textsubscript{2} in the air camera.

The quantity of O\textsubscript{2} consumed and of CO\textsubscript{2} produced it decides multiplying the frequency of ventilation, typically of 1 L/seg, by the change in the concentration of the gas. The EE is calculated using the consumption of O\textsubscript{2}, production of CO\textsubscript{2}.

The respiratory quotient is an important component in the determination of the IC and is defined as the relation that exists between (among) the production of CO\textsubscript{2} and consumption of O\textsubscript{2}: it has a value of 1.0 for the oxidation of carbohydrates, of 0.81 for the protein and of 0.71 for the fat\textsuperscript{16}.

At present, there are commercialized two types of indirect calorimeters which difference takes root in the method of obtaining and storage of the breathed air: The based ones on systems of closed circuit and on systems of opened circuit.

IC in closed circuit

This method is specially adapted at present for the study of small animals, it is not useful in the human study, since in spite of not needing analyzers of oxygen not of carbon dioxide, it does not allow periods of monitoring superior to 20 minutes.

IC in opened circuit

This method consists of the air traffic of flow and composition known (O\textsubscript{2} 14.978%, CO\textsubscript{2}: 5.004% and N\textsubscript{2} 79.987%) and in the determination of the decline of oxygen and increase of CO\textsubscript{2} in the air exhaled by the patient. In this system the produced CO\textsubscript{2} is absorbed inside the system, and is added O\textsubscript{2} to keep the volume of the gas constant.

In spite of the high cost of the infrared systems and for magnetic necessary for the breathing of the exhaled gases and of the possible escapes that can take place during its withdrawal, the most used calorimeters are based on this system, since they offer a high precision and allow to realize it measured metabolic medium-term.

IC’s different methods exist opened depending on the system of withdrawal of the exhaled air. Between them the stock exchange of Douglas, Oxilog, drafty bonnet, calorimeter of canopy and of entire body.

In the method with mask, the patient connects to a mouth mask, whereas in the method of camera of entire body, it needs a much more complex infrastructure.

There exist few studies that compare calorimetry with opened and closed circuit, nevertheless, there is mentioned that the closed circuit overestimates the EER\textsuperscript{2}.

I am interested in emphasizing here a series of limitations of the technology that must be considered in the estimation of the expense. Apart from the variability of the precision of the own systems of measure incorporated into the equipments, all the physiological
situations capable of altering in some sense the gaseous exchange of the organism, can alter the estimation of the metabolic expense. For example: changes in the balance acid - base, condition of hiper or hipo-ventilation, modifications in the pool of CO₂, owed to cutaneous losses (use of vasodilator) or even own reactions of the intermediary metabolism have to of be considering in the moment to evaluate the metabolic condition of the individual.

Impedance bioeléctrica (BIA)

It is a method that estimates the corporal compartments, included the quantity of liquid in the spaces intra and extracelulars. This technology is based on the resistance to the step of the alternating current. The lean fabric is highly conductive due to the great quantity of water and electrolytes that it contains, therefore it offers low resistance; on the contrary the fat, the skin(leather) and the bone are means of low conductivity and therefor of high resistance. At present it arranges of scales that have the equations incorporated in its software to determine the MBR1,2.

Nevertheless the dispersion of the results is important.

Methods of NOT REST

In spite of the fact that we are talking about the measurement of the EER. Methods of evaluation exist of not rest that they us can turn out to be useful for it.

IC in corporal total camera

In that the individual can remain for days in conditions of semirest. This one is a theoretically very simple, but very specialized technology, needs a complex structure and the use of costly instruments of measurement. With everything, the great limitation takes root in that it presents an artificial environment and therefore, not comparably with the conditions of free life.

Direct calorimetry CD

A crucial difference between this method and the CI camera is that in this case is needed to calculate all the heat that enters or goes out of the camera, which complicates methodologically the technology. It is potentially the most precise method, in strictly controlled conditions, which turns it into one of the methods of reference to validate other methods of measurement of the EETD and of the EER. Nevertheless, the enormous economic cost and the complex structure that it needs relegate it to the field of the (research).

Record of the cardiac frequency

This technology bases the fact that the cardiac frequency (CF) increases with the physical activity and that this increase relates narrowly with it consumption of oxygen inside a reasonable interval

The placement of a system of constant record of the CF, it would allow, at least theoretically, the estimation of the energetic expense from the consumption of oxygen, during periods habitual long of time, in which the individual might realize its activities.

For it, it is necessary to establish individually the straight line of existing regression between CF and VO₂. This first estimation would be done determining simultaneously the CF and the VO₂ by means of CI in rest and also during the accomplishment of exercises of variable intensity.

The basic problem is that the linear relation of both variables, gets lost with FC’s low levels (in which there are in the habit of being the majority of the individuals who realize moderate activities) to this point where the linearity gets lost, it is named CFFlex.

For it, instead of predicting the average of the energetic expense from the average of the CF, there are preferred systems of CF’s compilation minute to minute.

From here the EETD it is calculated supposing the EEB.

Water doubly marked

Administration oral route of a dose of water doubly marked with two stable isotopes deuterium and O₂ and posterior quantification for spectrometry of masses of the isotopic enrichment of any fluids (saliva, urin, dregs…) gathered in a time superior to seven days.

The Deuterium is distributed exclusively by the water, but Or by the water and the bicarbonates. The different elimination of both isotopes does not allow to find the elimination of the CO₂ and therefor to estimate the EETD. The precision is superior to that of IC in camera in 4%17.

But the high cost and the difficulty in the interpretation of the results relegate it use, at the moment to the research.

Method of dilution of the bicarbonate

Similar to the previous one but across the previous infusion with marked bicarbonate. This method needs diverse suppositions and corrections, and provided that for the final determination it refers to the production of CO₂ and VO₂, it is necessary to consider the respiratory average quotient, similar to the previous technology.
JUDGING methods

Predictive equations. The determination of the need of energy is a basic component in the approach of the food due to the fact that the balance assessment between consumption and EE has important implications for the health. In the practice, it is common to use equations of reference to estimate the EEB and to apply the method factorial to determine the energetic daily requirement.

The predictive equations (PE) usually have been developed by healthy persons and are based on analysis of regression that includes weight, height, sex and age as independent variables and in the measurement of the EER for IC as variable dependent; for example, the equation of the FAO/WHO/UNU 1985 are in mind the sex, the groups of age and the weight. Other authors bear in mind the index of corporal mass (BMI).

The principal PE that have been elaborated for the estimation of the EER are:

Equation of Harris and Benedict

The original publication dates back of 1919, the studies realized by these authors were based on BMI's measurements of 136 men and 103 women on the Laboratory of Carnegie’s Nutrition on Boston; there were used statistical rigorous methods that gave like proved the following equations:

\[
\text{Men EER} = 66.4730 + 13.7516 \times W + 5.0033 \times T - 6.7759 \times A \\
\text{Women EER} = 665.0955 + 9.5634 \times W + 1.8496 \times T - 4.6756 \times A
\]

W = I weigh in Kg., T = it deals in cm., A = age in years.

Quenouille’s Equation

Quenouille and cols in 1951 were the first ones in elaborating a study with base in determinations of the TMB; the information of Quenouille there included persons who were living in the tropic and they oriented to examine the role of the ethnicity and of the climate on the TMB, nevertheless, the equation has not been very used.

This information was included later in the bases of information of Shofield’s studies, nevertheless, these were presenting such limitations as: little information on breast-fed babies, teenagers and major adults; lack of information of persons from developing countries; few ethnic and geographical variability (there was included a disproportionate number of Italians, 47%) and it lowers incorporation of individuals of tropical regions.

PAs levels and the factors that were considered to calculate the EET were: Gender and activity.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Slight Activity</th>
<th>Moderate Activity</th>
<th>Heavy Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man</td>
<td>1.55</td>
<td>1.76</td>
<td>2.10</td>
</tr>
<tr>
<td>Woman</td>
<td>1.56</td>
<td>1.64</td>
<td>1.82</td>
</tr>
</tbody>
</table>

Equations of Oxford

Between 1980 and 2000, one group of experts selected studies of measurement of the GE that included the following aspects:

- Age, weight and genre; description of the experimental conditions and of the equipment used for the measurement of the MBR; measurements in healthy subjects, in condition postabsorption and without previous PA and, description of the ethnicity and of the geographical location.
- From the database they were excluded to all the Italian subjects of Shofield’s studies and there was included information of inhabitants of the tropics. From these variables there was generated a database called of Oxford, which bore in mind 10552 MBR’s values.

With the equations developed (Table II) the values of the TMB, in major of 18 years they were lower than the obtained ones with the equations of the FAO/WHO/UNU of 1985.

The comparison between the equations of Oxford bearing the corporal weight in mind and those of the FAO/WHO/UNU 1985 for MBR’s estimation shows itself in the table III.

**Shofield’s Equations (FAO/WHO/UNU) 1985**

The Experts’ Committee of the FAO/WHO/UNU in 1985, developed a series of PE to estimate the energetic requirement with base in some premises: the energetic requirement must be based on the measurement of the GE and not on the ingestion; the organism has the aptitude to adapt to low unexploits and, the requirement refers to groups and not to individuals.

This Committee adopted the method factorial and proposed the application of multiple of the TMB; in the equations. They considered age, sex and corporal weight.

They were in use as base principally the information of Shofield’s studies, nevertheless, these were presenting such limitations as: little information on breast-fed babies, teenagers and major adults; lack of information of persons from developing countries; few ethnic and geographical variability (there was included a disproportionate number of Italians, 47%) and it lowers incorporation of individuals of tropical regions.

FAO/WHO/UNU’s Equations (2001)

They developed from Shofield’s database used in the estimation of the MRB (1985); they were conside-
red to be three AF’s levels and it was chosen for ranges for every category; in addition, there was adopted the term(ends) of way of life more than that of labor occupation to define PA’s level:

- Sedentary or way of life with slight activity: 1.40-1.69
- Active or way of life moderately active: 1.70-1.79
- Vigorous or vigorously active way of life: 2.0-2.4

Historically, the nutritionists dietitians have used the PE to estimate the EER, but the studies suggest that this equation overestimates the MBR between 10 and 15%, specially in persons of low weight;

That of the FAO/WHO/UNU, validated by Muller (2004) also it overestimates the BMR in some communities.

Schofield’s equation and that of the FAO/WHO/UNU does not bear the height in mind because they think that it does not contribute to the estimation of the EER in healthy individuals (less than 0.1% of the value of the pre-established EER), is based only on the weight. Nevertheless, the Institute of Medicine of the United States affirms that the incorporation of this variable can reduce slightly the mistake of prediction.

Nowadays, it thinks that the climate is a determining variable, because it can influence the BMR; the persons who live in hot climate tend to have a BMR lower than those who live in cold climate, still after fitting for size and corporal composition; therefore, it is possible that the climate change and the migrations other geographical zones concern, at least partially, the BMR

### Clinical and practical application

Report of the technologies of evaluation of the energetic expense described previously, they remain relegated, by its complexity and cost to the area of the research. For a long time the indirect calorimetry, she remained also restricted to this field, whereas in the clinic there were preferred equations of prediction based on simple measurements as the weight and the height.

Nevertheless, the technological advances have allowed the development of precise light and attainable equipments that they have been finding it to go well together in the clinical space.

### Table II

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age / years</th>
<th>MBR (Kcal/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>10-18</td>
<td>15.6 x W + 266 x T + 299</td>
</tr>
<tr>
<td></td>
<td>18-30</td>
<td>14.4 x W + 313 x T + 113</td>
</tr>
<tr>
<td></td>
<td>30-60</td>
<td>11.4 x W + 541 x T – 137</td>
</tr>
<tr>
<td></td>
<td>&gt; 60</td>
<td>11.4 x W + 541 x T – 256</td>
</tr>
<tr>
<td>Women</td>
<td>10-18</td>
<td>9.40 x W + 249 x T + 462</td>
</tr>
<tr>
<td></td>
<td>18-30</td>
<td>10.4 x W + 615 x T – 282</td>
</tr>
<tr>
<td></td>
<td>30-60</td>
<td>8.18 x W + 502 x T – 11.6</td>
</tr>
</tbody>
</table>

### Table III

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age / years</th>
<th>Oxford MBR (Kcal /día)</th>
<th>FAO/WHO/UNU 1985 MBR (Kcal/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>10-18</td>
<td>18.4 x W + 581</td>
<td>17.686 x W + 658.2</td>
</tr>
<tr>
<td></td>
<td>18-30</td>
<td>16.0 x W + 545</td>
<td>15.057 x W + 692.2</td>
</tr>
<tr>
<td></td>
<td>30-60</td>
<td>14.2 x W + 593</td>
<td>11.472 x W + 873.1</td>
</tr>
<tr>
<td></td>
<td>&gt; 60</td>
<td>13.5 x W + 514</td>
<td>11.711 x W + 587.7</td>
</tr>
<tr>
<td>Mujeres</td>
<td>10-18</td>
<td>11.1 x W + 761</td>
<td>13.384 x W + 692.6</td>
</tr>
<tr>
<td></td>
<td>18-30</td>
<td>13.1 x W + 558</td>
<td>14.818 x W + 486.6</td>
</tr>
<tr>
<td></td>
<td>30-60</td>
<td>9.74 x W + 694</td>
<td>8.126 x W + 845.6</td>
</tr>
</tbody>
</table>
The indirect calorimetry has an undeniable practical interest in the study of numerous clinical situations as the obesity, the malnutrition, trauma, sepsis, renal and hepatic failure, cancer, multiorgan failure, serious infections as the HIV, the calculation of energetic requirements of critical patients and, in the field that occupies me, of persons with an intense physical wear and athletes of different sports modalities.

Summary

Report of the technologies of evaluation of the energetic expense described in this review, they remain relegated, for its complexity and cost to the area of the research. For a long time the indirect calorimetry, she remained also restricted to this field. Nevertheless, the technological advances have allowed the development of precise light and attainable equipments that allow that at present it should be a very useful method in the clinical space of the determination of the GER, in wide groups of population, it recovers, with different types of pathology and also submitted to an intense physical wear as the athletes of different sports modalities.

References