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Artículo Original

Resting Energy Expenditure, comparison of predictive formulas with bioimpedance: Peruvian population

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Abstract: Resting Energy Expenditure, comparison of predictive formulas with bioimpedance: Peruvian population. Introduction: In areas with limited access to healthcare systems, Resting Energy Expenditure (REE) estimation is performed using predictive equations to calculate an individual's caloric requirement. One problem is that these equations were validated in populations with different characteristics from those in Latin America, such as race, height, or body mass, leading to potential errors in the prediction of this parameter. **Objective:** To determine the REE using predictive formulas compared with bioimpedance in Peruvians. **Materials and methods:** A comparative analytical cross-sectional study with secondary database analysis of the CRONICAS cohort. **Results:** we worked with a total of 666 subjects. The Mjeor equation was the one with the highest rating of 0.95, a lower mean absolute percentage error (MAPE) of 4.69%, and equivalence was found with the REE values. In the multiple regression, it was observed that the Mjeor equation was the one that least overestimated the REE, increasing 0.77 Kcal/day (95% CI: 0.769-0.814; p<0.001) for each point that increased the REE determined by bioimpedance. The strength of association between Mjeor and bioimpedance was 0.9037. Furthermore, in the regression of the data (weight, height, age) in the Mjeor equation it was observed that the coefficients obtained were the same as those used in the original equation. **Conclusions:** The Mjeor equation seems to be the most adequate to estimate the REE in the Peruvian population. Future prospective studies should confirm the usefulness of this formula with potential utility in primary health care. **Arch Latinoam Nutr 2024; 74(2): 107-118.**

Keywords: calorimetry, bioimpedance, resting energy expenditure, predictive formulas.

Resumen: Gasto Energético en Reposo, comparación de fórmulas predictivas con la bioimpedancia: población peruana. Introducción: En zonas con acceso limitado a sistemas de salud, la estimación del Gasto Energético en Reposo (GER) se realiza utilizando ecuaciones predictivas para calcular el requerimiento calórico de un individuo. Uno de los problemas es que estas ecuaciones fueron validadas en poblaciones con características diferentes a las latinoamericanas, como raza, talla o masa corporal, lo que conlleva a potenciales errores en la predicción de este parámetro. **Objetivo:** Determinar el GER mediante fórmulas predictivas comparadas con la bioimpedancia en peruanos. **Materiales y métodos:** Estudio transversal analítico comparativo con análisis secundario de base de datos de la cohorte CRONICAS. **Resultados:** Se trabajó con un total de 666 sujetos. La ecuación de Mjeor fue la que obtuvo la puntuación más alta de 0,95, un error medio porcentual absoluto (MAPE) inferior de 4,69%, y se encontró equivalencia con los valores del GER. En la regresión múltiple, se observó que la ecuación de Mjeor fue la que menos sobreestimó el GER, aumentando 0,77 Kcal/día (IC 95%: 0,769-0,814; p<0,001) por cada punto que aumentaba el GER determinado por bioimpedancia. La fuerza de asociación entre Mjeor y bioimpedancia fue de 0,9037. Además, en la regresión de los datos (peso, talla, edad) de la ecuación de Mjeor se observó que los coeficientes obtenidos eran los mismos que los utilizados en la ecuación original. **Conclusiones:** La ecuación de Mjeor parece ser la más adecuada para estimar el GER en la población peruana. Futuros estudios prospectivos deberán confirmar la utilidad de esta fórmula para su potencial utilidad en la atención primaria de salud. **Arch Latinoam Nutr 2024; 74(2): 107-118.**

Palabras clave: calorimetría, bioimpedancia, gasto energético en reposo, fórmulas predictivas.

Introduction

Obesity is a worldwide epidemic (1), that disrupts the energy balance (2) and is an independent risk factor for mortality (3). In Peru, less than 11% of the population has a healthy diet, and

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there is a high prevalence of excess weight, reaching almost 70% (4). Planning a diet for overweight and obese patients involves a period of weight reduction, during which the caloric intake should be significantly lower than the Resting Energy Expenditure (REE) plus physical activity (5), followed by a weight stabilization phase that covers nutritional needs and avoids further weight gain (6). The Peruvian National Institute of Health (INS) promotes the "Dietary Guidelines for the Peruvian Population", but mentions that while preventive measures can avoid a further increase in obesity, intervention strategies aimed at changing eating and physical activity habits are essential (7).

REE measurement plays an important role in the evaluation of the nutritional status of individuals (8). Indirect Calorimetry (IC) is one of the most accurate methods for its measurement (9-11), but it is expensive, requires specialized personnel and is only available in a few clinical centers (8). Therefore, the use of Bioelectrical Impedance Analysis (BIA), which calculates REE takes into account total body water and lean body mass, has become increasingly popular and is accepted for measuring REE (8). Studies show that both IC and BIA are adequate for measuring REE (8).

In clinical practice, especially in remote areas with limited access to healthcare systems, REE estimation is performed using various predictive equations to calculate an individual's caloric requirement. Equations such as those from FAO/WHO/UN (12) or those developed by Harris and Benedict (13) may be used. One problem is that these equations were validated in populations with different characteristics from those in Latin America, such as race, height, or body mass (14-16), leading to potential errors in the prediction of this parameter that may over- or underestimate values in individuals with particular characteristics (14,17,18). Hence the importance of evaluating and using the most accurate predictive equation to estimate the REE in a particular population (19-21), given its importance in public health when applying interventions that modify eating and lifestyle habits to regulate and control weight.

In this context, the present study aimed to compare the estimation of REE using the predictive equations Harris-Benedict (HB) (13), Mifflin-St Jeor (Mjeor) (22), Food and Agriculture Organization of the United Nations and World Health Organization (WHO) (12), Institute of Medicine (IOM) (22), Rapid Formula (RF) and Valencia (VA) (23), in the Peruvian population.

Materials and methods

Study design

Comparative analytical cross-sectional study, carried out through a secondary database analysis of the CRONICAS cohort (primary study), which was published by the CRONICAS research group of the Universidad Peruana Cayetano Heredia (24).

Study population

The primary study groups were defined by simple random sampling. The evaluation was performed in the years 2012-2013. A sample of 989 subjects was obtained. In our study, after the inclusion and exclusion criteria, a total of 666 subjects were obtained.

Eligibility and exclusion criteria

In the primary study, all study participants had to be 35 years old or older, be full-time residents in the area (Lima, Tumbes, urban Puno and rural Puno) and be able to understand all the study procedures and give informed consent. Thus, we excluded participants who were pregnant, who were cognitively incapable of giving informed consent or answering a questionnaire, and who had a physical disability that prevented anthropometric measurements, blood pressure, or if they had active pulmonary tuberculosis or cancer. Only one participant per household was enrolled.

In this study, only subjects presenting the variables of interest (resting energy expenditure in Kcal/day) were included. Participants without weight, age, height, and actual weight were excluded. In addition, outliers were eliminated to preserve the linearity of the data obtained when calculating the predictive formulas.

Variables and measurement

Response variable

Resting energy expenditure calculated by bioimpedance was considered. Resting energy expenditure was measured using bioelectrical impedance using the TBF-300A body composition analyzer (TANITA Corporation, Tokyo, Japan). Measurements were performed according to the manufacturer's specifications.

Exposure variables

Resting energy expenditure estimated using the six predictive equations, which will be: 1. Harris-Benedict (HB), 2. Mifflin-St Jeor (Mjeor), 3. Food and Agriculture Organization of the United Nations and World Health Organization (WHO), 4. Institute of Medicine (IOM), 5 Rapid Formula (RF) y 6. Valencia (VA). They will be determined using the weight, actual weight, height, and age variables.

The equations and their references will be shown below.

Predictive equations for estimating resting energy expenditure:

HB

Male=66.47+[13.75×weight (kg)]+[5×height (cm)]-(6.75×age)

Female=655.09+[9.563×weight (kg)]+[1.84×height (cm)]-(4.676×age)

Mjeor

Male=[9.99×weight (kg)]+[6.25×height (cm)]-[4.92×age(years)]+5

Female=[9.99×weight (kg)]+[6.25×height (cm)]-[4.92×age(years)]-161

WHO

Male

18-30 years=15.3×weight+679

31-60 years=11.6×weight+879

>60 years=13.5×weight+487

Female

18-30 years=14.7×weight+496

31-60 years=8.7×weight+829

>60 years=10.5×weight+596

IOM

247-(2.673×age)+[401.5×height(m)]+[8.6×weight(kg)]

Rapid estimation

16.2×actual weight (kg)

Valencia

Male

18-30 years=[15.3×weight(kg)]+747

31-60 years=[13.08×weight(kg)]+693

>60 years=[14.21×weight(kg)]+429

Female

18-30 years=[11.02×weight(kg)]+679

31-60 years=[10.92×weight(kg)]+677

>60 years=[10.98×weight(kg)]+520

Control variables

The other variables were age (in years), gender (male and female), age categorized (younger than 60 years and older than 60 years), group (urban, migrant), marital status (without partner, with partner), smoking (non-smoker, occasional, daily), alcohol (no, yes) and work (no, yes).

Procedures

The database of the primary study is freely accessible, without restrictions (25). The researchers accessed the scientific information, the variables of interest for the study were taken and the present manuscript was written.

Statistical analysis

Statistical analysis was performed with STATA v16.0 software. For the descriptive analysis, the qualitative variables were summarized in percentages, while the quantitative variable was presented as mean and standard deviation. In the bivariate analysis for the characteristics of the study subjects, Student's t-test was used to compare the means of the groups, and the ANOVA test was used to compare the means of various groups. For the bivariate analysis between the REE estimation formulas, the Pearson test was used. The graphs were made using the R statistical program version 4.3.1. The Mean Absolute Percentage Error (MAPE) was calculated using the MLmetrics library of RStudio. In addition, to determine the equivalence of the values those obtained by bioimpedance, a two-tailed bilateral test (TOST) (26) with a 90% confidence interval was used with RStudio.

The multivariate generalized linear model of the Gaussian family (27) made from a linear regression model. The variables included in the multivariate model were group, smoker, work, alcohol, marital status. These variables were chosen from the literature review. The measure of association was the beta coefficient with its respective 95% confidence interval (CI). The strength of association between the main variable and the two predictive formulas with the highest correlation was measured using the R-squared. A sex-stratified regression model was constructed for the formula with the highest correlation, by regressing the variables used in the formula calculation (age, height, weight). An analysis was completed the exclusion of outlier data.

Ethical standards disclosure

The present study has been approved by the Research Ethics Committee of the Faculty of Human Medicine of the Universidad Ricardo Palma (PG 183-2022). In addition, as it is a secondary data analysis, there was no contact with human subjects, therefore, the possible risks for the subjects of the analysis are minimal. It is important to mention that the database is freely accessible to the general public. Ethical approval for the primary study was obtained from the ethics committees of the Universidad Peruana Cayetano Heredia (cod. 51103) and the London School of Hygiene and Tropical Medicine.

Finally, the ethical principles outlined in the Declaration of Helsinki were respected during the implementation of the study.

Results

The original study included 989 subjects. A total of 202 subjects were excluded because they did not present the main variable of interest (resting energy expenditure determined by bioimpedance); also, all subjects who lacked either weight, actual weight or height (95), because these variables are necessary to determine the predictive formulas, in this sense 26 outliers were eliminated to comply with linearity. Therefore, we worked with 666 subjects (Figure 1).

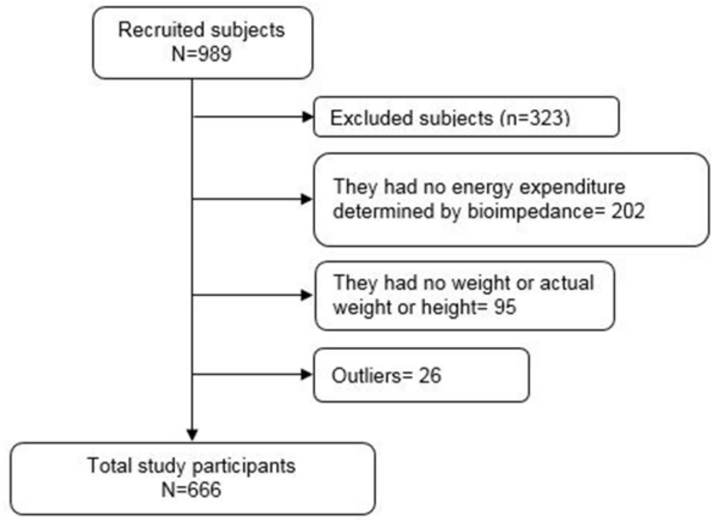

Figure 1. Flowchart of participant selection.

The univariate statistical analysis was descriptive. The mean age of the population was 47 years, most were under 60 years of age (77.33%), the mean age of the women was 47.61 years and the mean age of the men was 46.75 years. The predominant gender was female (54.65%), migrants were predominant (76.13%), those who had a partner represented 80.48%, those who smoked daily represented 2.10%. Those who consumed alcohol accounted for 7.51%, and finally, those who worked were predominant (73.72%). The mean energy expenditure determined by bioimpedance was 1305.09 (Table 1).

For the REE determined with respect to gender, it was observed that the male gender had a higher average of kilo calories per day compared to the female gender; also with age, it was found that those under 60 years of age had a higher average of kilo calories per day compared to those over 60 years of age; likewise, those who have a partner had a higher average of kilo calories per day compared to those without a partner; those who consume alcohol had a higher average of kilo calories per day compared to those who did not consume alcohol; in the same way, those who work had a higher average of kilo calories per day compared to those who do not work. Apart from smoking, the rest of the results showed a statistically significant association (Table 2).

It was observed that there is a positive correlation between the resting energy expenditure determined by bioimpedance and the resting energy expenditure determined by the six predictive formulas. In Figure 2, we see the linearity of the energy expenditure values (red line) with the values of the predictive formulas

Table 1. Sociodemographic characteristics of the subject sample.

Characteristics	n (%)
Age (categorized)	
< 60 years old	515 (77.33)
> 60 years old	151 (22.67)
Gender	
Male	302 (45.35)
Female	364 (54.65)
Group	
Urban resident	159 (23.87)
Migrant	507 (76.13)
Marital status	
Without partner	130 (19.52)
With partner	536 (80.48)
Smokes	
Do not smoke	583 (87.54)
Occasionally	69 (10.36)
Daily	14 (2.10)
Alcohol	
No	616 (92.49)
Yes	50 (7.51)
Work	
No	175 (26.28)
Yes	491 (73.72)
	Average (standard deviation)
Age	47.14 (10.99)
Age by gender	
Male	46.75 (11.05)
Female	47.61 (10.73)
Bioimpendence energy expenditure	1305.09 kcal/day (156.28)*
Predictive formulas	
WHO	1430.59 kcal/day (155.72)*
Valencia	1421.35 kcal/day (171.66)*
Rapid estimation	1053.35 kcal/day (169.01)*
Harris Benedict	1357.27 kcal/day (157.43)*
IOM	62641.95 kcal/day (3121.48)*
Mjeor	1271.99 kcal/day (188.25)*

* Resting energy expenditure in kilocalories per day

Table 2. MAPE and Pearson's correlation coefficient between the 6 predictive formulas and bioimpedance for resting energy expenditure in a sample of Peruvians.

Characteristics	Bioimpedance resting energy expenditure	*P*
Gender		<0.001*
Male	1421.429 (133.004) †	
Female	1215.749 (123.6626) †	
Age (categorized)		<0.001*
< 60 years old	1334.032 (156.2968) †	
> 60 years old	1229.89 (164.3397) †	
Group		0.0004*
Urban resident	1352.246 (177.483) †	
Migrant	1296.564 (157.1096) †	
Marital status		<0.001*
Without partner	1246.738 (161.2277) †	
With partner	1324.495 (161.3345) †	
Smokes		0.209**
Do not smoke	1290.935 (157.7162) †	
Occasionally	1428.773 (156.5596) †	
Daily	1465.467 (107.5864) †	
Alcohol		<0.001*
No	1299.254 (160.6108) †	
Yes	1437.63 (149.4857) †	
Work		<0.001*
No	1209.77 (145.4166) †	
Yes	1345.742 (155.3432) †	

† Average (standard deviation)
* Performed with Student's t-test, significance level $p < 0.05$.
** Performed with Anova test, significance level $p < 0.05$.

(gray shade) and the dispersion purple dots. In addition, the predictive formula Mjeor is the one with the best linearity and the lowest dispersion.

The correlation was statistically significant between the bioimpedance-determined weight energy expenditure and the predictive formulas. The formula with the highest correlation was the Mjeor, which had a very strong positive correlation of 0.95, followed by the HB formula which had a correlation of 0.90. The formula with the highest correlation was Mjeor, which had a very strong positive correlation of 0.95 and had the lowest

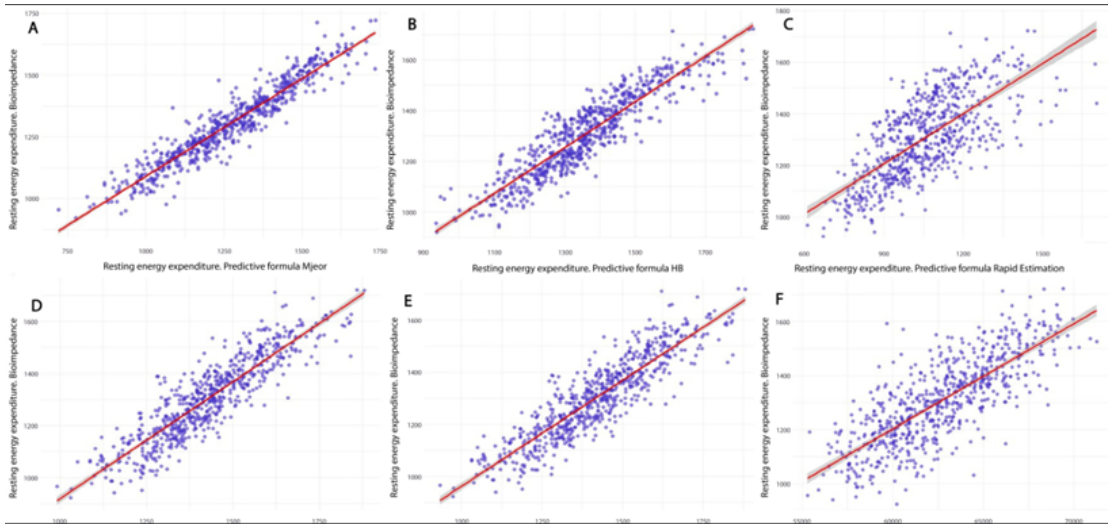

Figure 2. Scatter plot of REE by bioimpedance versus the six equations that estimate REE.

mean absolute percentage error (MAPE) of 4.69% (Table 3).

In the bilateral two-tailed test (TOST), equivalence was found in all cases with the ranges described in table 4. It was verified that the Mjeor formula was the one with the smallest difference (-33,114 kcal/day) with respect to the values found by bioimpedance and also a smaller equivalence interval; compared to the other formulas predictive of resting energy expenditure (Table 4).

Figure 3 shows the range of equivalence between the energy expenditure in reweight determined by bioimpedance and the predictive formulas. The Mjeor formula had a 90% confidence interval (CI) between -37.114 and -29.114; kcal/day; The HB formula had a 90% CI of between 47,849 and 56,489 kcal/day.

For the first analysis, in the crude regression, it was found in the population that the average energy expenditure determined by Mjeor increases by 0.78 Kcal/day (IC95%: 0.769-0.808; p<0.001) and the average energy expenditure determined by HB increases by 0.90Kcal/day (IC95%: 0.868-0.932; p<0.001); for each point that increases the energy expenditure determined by bioimpedance. Then, in the adjusted regression, the association observed in terms of direction and magnitude was preserved. It was observed that the average energy expenditure determined by Mjeor increases by 0.77 Kcal/day (95%CI: 0.769-0.814; *p*<0.001) and the average energy expenditure determined by HB increases by 0.85Kcal/day (95%CI: 0.719-0.776; *p*<0.001); for each point that increases the energy expenditure determined

Table 3. MAPE and Pearson's correlation coefficient between the 6 predictive formulas and bioimpedance for resting energy expenditure in a sample of Peruvians.

Predictive formulas	MAPE*	Bioimpedance	*p*
Mjeor	4,69%	0.9506	<0.001*
HB	5,14%	0.9069	<0.001*
WHO	8,99%	0.8946	<0.001*
Valencia	8,38%	0.8944	<0.001*
IOM	97,92%	0.7778	<0.001*
Rapid estimation	25,69%	0.6997	<0.001*

*MAPE: mean absolute percentage error.

Table 4. Bilateral two-tailed test (TOST) between the 6 predictive formulas and bioimpedance for resting energy expenditure in a sample of Peruvians.

Predictive formulas	Mean (standard deviation)	Difference	*IC 90%*	*Equivalence interval*
Mjeor	1272 (188.25)	-33.114	(-37.11– -29.11)	(-35.5 – -29)
HB	1357.3 (157.43)	52.169	(47.85 – 56.49)	(47 – 57)
WHO	1430.6 (155.72)	125.48	(120.91 – 130.05)	(120 – 131)
Valencia	1421.3 (171.166)	116.25	(111.35 – 121.15)	(110 – 122)
IOM	62642 (3121.5)	61337	(61145.3 – 61528.4)	(61100 – 61600)
Rapid estimation	1053.4 (169)	-251.75	(-259.83 – -243.67)	(-265 – -240)

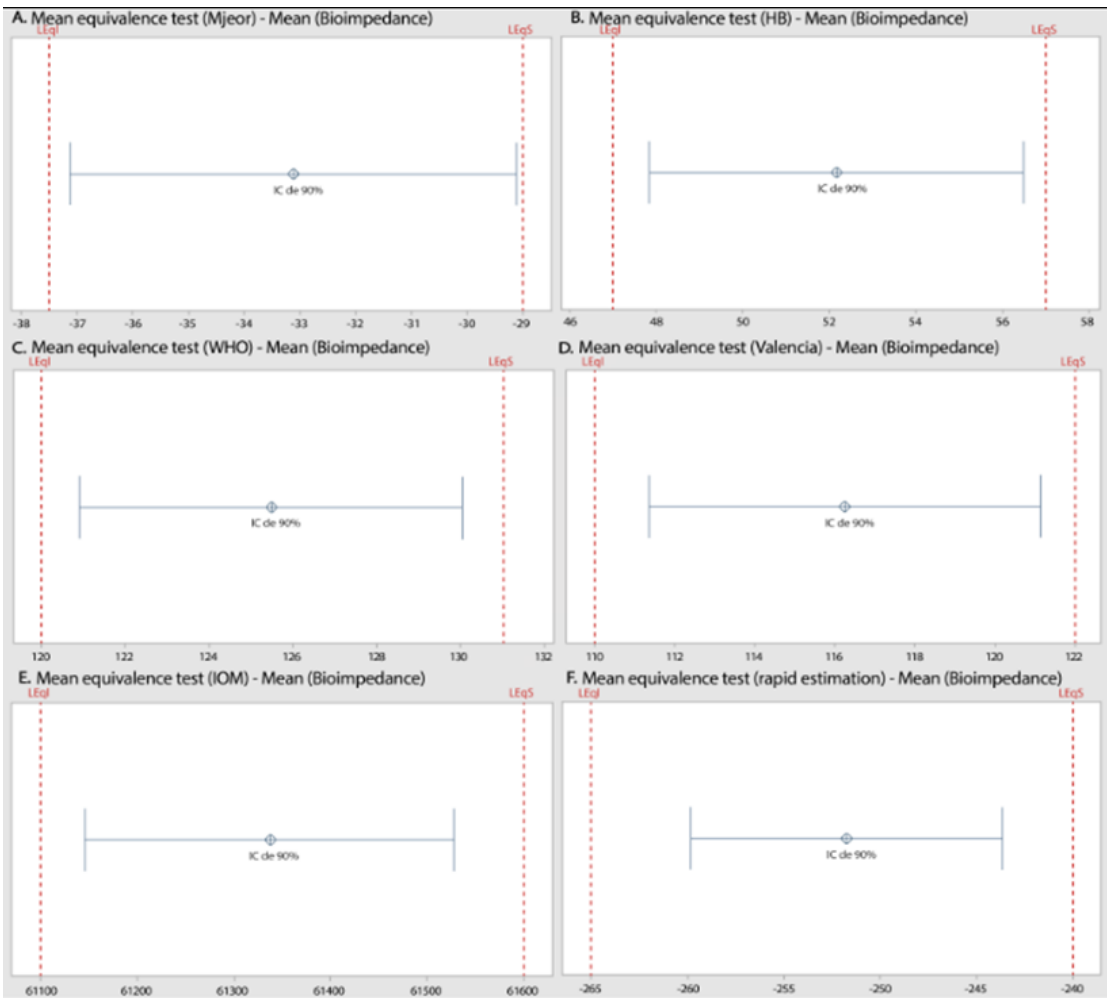

Figure 3. TOST for the equivalent confidence intervals between energy expenditure at rest using the 6 predictive formulas and bioimpedance. A. Equivalence between the Mjeor predictive formula and bioimpedance (90% CI, LEqI -37.114 and LEqS -29.114). B. Equivalence between the HB predictive formula and bioimpedance (90% CI, LEqI 47.849 and LEqS 56.489). C. Equivalence between the WHO predictive formula and bioimpedance (90% CI, LEqI 120.91 and LEqS 130.05). D. Equivalence between the predictive formula Valencia and bioimpedance (90% CI, LEqI 111.35 and LEqS 121.15). E. Equivalence between the IOM predictive formula and bioimpedance (90% CI, LEqI 61145 and LEqS 61528). F. Equivalence between the Rapid Estimation predictive formula and bioimpedance (90% CI, LEqI -259.82 and LEqS -243.67). LEqI: Lower equivalence limit. LEqS: Upper equivalence limit. CI: confidence interval.

Table 5. Crude and adjusted linear regression model comparing the two predictive formulas with the highest correlation and bioimpedance to determine resting energy expenditure in a sample of Peruvians

Characteristics	Crude Analysis				Adjusted Analysis *		
	Coef β	IC 95%	*p***	R2	Coef β	IC 95%	*p***
Mjeor	0.78	0.769 - 0.808	<0.001	0.9037	0.77	0.769 - 0.814	<0.001
HB	0.90	0.868 - 0.932	<0.001	0.8225	0.85	0.719 - 0.776	<0.001
WHO	0.89	0.863 - 0.931	<0.001	0.8004	0.86	0.828 - 0.903	<0.001
Valencia	0.81	0.783 - 0.845	<0.001	0.7999	0.78	0.752 - 0.821	<0.001
IOM	0.83	0.736 - 0.841	<0.001	0.6049	0.73	0.533 - 0.831	<0.001
Rapid estimation	0.84	0.596 - 0.997	<0.001	0.4896	0.72	0.557 - 0.847	<0.001

* Adjusted for group, smoker, working, alcohol, marital status
** significant p value <0.05

by bioimpedance. This was adjusted for confounding group covariates: smoking, work, alcohol consumption and marital status. In addition, the strength of association between Mjeor and HB with bioimpedance was 0.9037 and 0.8225 respectively (Table 5).

In addition, a sex-stratified regression model was performed using the variables (weight, height, and age) used to calculate the formula. Mjeor's formula uses the variables weight, height, and age, which are multiplied by coefficients, and also adds up to a constant; there are variations according to sex. In the case of men, the coefficients multiplied by the variables weight, height, and age are maintained; however, there is a minimal variation in the constant added at the end, which ranges from 5 to 4.999. In the case of women, all the values of the coefficients and the constant remained the same. The Mjeor formula showed a highly significant R2 of 0.997 (Table 6).

Tabla 6. Estimated regression model for formula Mjeor.

Miffin St. Jeor Predictive Formula				
Male	[9.99 x weight (kg)] + [6.25 x height (cm)] - [4.92 x age (years)] + 5			
Regression	Coefficient	IC 95%	*p*	R2
Weight	9.99	9.99 – 9.99	< 0.001	0.997
Size	6.25	6.249 - 6.250	< 0.001	
Age	-4.92	- 4.92 – -4.92	< 0.001	
Constant	4.999999	4.999 – 5.001	< 0.001	
Female	[9.99 x weight (kg)] + [6.25 x height (cm)] - [4.92 x age (years)] – 161			
Regression	Coeficiente	IC 95%	*p*	R2
Weight	9.99	9.99 – 9.99	< 0.001	0.997
Size	6.25	6.249 - 6.250	< 0.001	
Age	-4.92	- 4.92 – -4.92	<0.001	
Constant	-161	-161.001 – -160.999	< 0.001	

* significant p value <0.05

Discussion

This was the first report to compares predictive equations that measure resting energy expenditure to determine which of these equations is the most accurate in the Peruvian population; the results found indicated that the equation that best predicts the REE for the study population is the Mjeor equation, it was also observed in the regression of this equation with the data (age, weight, height) of the Peruvian population that the coefficients were equal to the original formula, therefore, future studies could validate this equation in the general Peruvian population.

REE varies from person to person, the main variables being height, body composition (28), age (29), gender, lean mass (30), hormone production (31) and altitude (32, 33). In our study, this variation was found with the variables gender, age, urban or migrant group, marital status, and alcohol consumption. This can be explained by the fact that a variation in body size, such as weight and height (which are different in women and men) translates into heat-producing units at the level of organs and tissues; that is why the equations evaluate men and women separately (34). In the case of a woman with the same weight as a man, she has a greater relative amount of adipose tissue, and also the potential factor of musculature (35,36). In addition, alcohol consumption and smoking may be factors that modify the REE according to the American Dietetic Association (37,38). Our study did not evaluate altitude or lean mass, because this information was not available. But it has been seen they can influence REE; this because O2 transport in native Andeans has unique characteristics compared to populations acclimatized to altitude, they would have a higher efficiency in O2 transfer and use (32), this physiological adaptation would influence basal metabolism (33) and it has been seen that variations in basal metabolic rate between individuals is due to differences in lean mass (30).

One of the most accurate methods for measuring energy expenditure is indirect calorimetry (IC) and the double-labeled water technique (9-11). But they are expensive, time-consuming, and not available in all clinical centers. It has been seen that both IC and BIA are adequate for measuring REE (8), in addition to the fact that the latter is more convenient, optimizes the patient time and does not require prolonged fasting (39,40). Despite this, it is not found in all first-level healthcare centers in regions far from large cities, as in the case of Latin American countries, so REE predictive equations that are quick and easy to apply have been developed. But these equations were created in populations different from the Latin American population, in relation to body composition, ethnicity, health status, age, among others (14,15,41).

One of the most popular equations taught in human medical schools and most widely used is the HB equation (13,17). This was originally validated in 239 white subjects of normal body weight (13). However, according to the results of this study, it would not be the most appropriate for the Peruvian population, since it was found that the Mjeor equation had the strongest correlation to determine the REE, followed by the HB. This was similar to a study comparing Mjeor, HB, Ireton-Jones and Carrasco's Rapid Estimation equations, carried out in a Chilean population with morbid obesity; in which it was found that the Mjeor equation and the Rapid Estimation were the best for the estimation of the REE (9). Another research in Chilean population found that the HB equation was not very accurate in estimating the REE (42). A work done in a European population found that the HB equation is the most accurate in comparison with the Mjeor (43). Another study carried out in a Chilean population with normal weight found that the Mjeor equation showed better accuracy and lower magnitude of error, with less overestimation and good concordance (44). The fact that an equation presents a very high correlation could be interpreted as meaning that the equation would be the most precise and reliable to measure the REE with respect to the values obtained by the standard goal. The accurate estimation of the REE has a main role in the strategies for interventions focused on the management of overweight and obesity because it has been shown that a decrease of 3500 kcal below the total energy expenditure allows a decrease of 0.5-1kg of weight per week (45). Likewise, when using a predicative equation with a greater overestimation of REE, the excess ingested is deposited in the body, approximately a positive balance of 6600-8000 kcal, generates an increase of 1 kg of body weight (46).

In conclusion, the Mjeor equation seems to be the most appropriate for estimating the REE in the Peruvian population, because it was the formula that obtained the highest correlation and had the lowest absolute percentage error. Additionally, the Mjeor formula showed a highly significant R2 of 0.997. Therefore, in future studies, if the results are confirmed prospectively, the importance of the Mjeor equation would be in its potential application in public health patients that require weight regulation and control, since it would only require three simple data (weight, height, age) that are easy to obtain at the first level of care.

Limitations of the study

The study carried out had some limitations. First, indirect calorimetry (IC) was not considered for the calculation of the resting energy expenditure, because this variable was not available in the database; however, the use of bioimpedance has become increasingly popular and accepted (7), because it has a good correlation with IC for estimating REE (11). Furthermore, the applicability of IC would not be feasible in large populations. Second, the population is made up of three representative departments of the country, so future studies that include larger populations and diverse ethnic groups of the country would be necessary. Third, we did not have data on altitude of residence or lean mass ratio because they were not included in the primary study. But they will be variables considered in future studies.

Contribution to the field statement

REE measurement plays an important role in the evaluation of the nutritional status of individuals. Indirect calorimetry is one of the most accurate methods for its measurement, but it is expensive and requires specialized personnel. Therefore, the use of bioelectrical impedance analysis has become increasingly popular and is accepted for measuring REE. In clinical practice, especially in remote areas with limited access to healthcare systems, REE estimation is performed using various predictive equations to calculate an individual's caloric requirement. Equations such as those from FAO/WHO/UN or those developed by Harris and Benedict may be used. One problem is that these equations were validated in populations with different characteristics from those in Latin America, such as race, height, or body mass, leading to potential errors in the prediction of this parameter that may over- or underestimate or underestimate values in individuals with particular characteristics. This is the first report that compares predictive equations that measure resting energy expenditure to determine which of these equations is the most accurate in the Peruvian population; the results found indicate that the equation that best predicts the resting energy expenditure for the study population would be the Mifflin-St Jeor equation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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