R E S P Y N
Revista Salud Pública y Nutrición

COMPARISON OF PERCEIVED WEIGHT AS IDEAL AGAINST IDEAL BODY WEIGHT FORMULAS AND BODY MASS INDEX OF 22 KG/M² IN YOUNG ADULT WOMEN.

Ramirez López Erik. [1] Puente Hernandez Debbie.[1] Negrete Lopez Nohemi Liliana.[1] Serna-Gutierrez Araceli.[2] Calderón-Ramos Zuli.[3] Omaña-Covarrubias Arianna.[3] Flores-Guillen Elena.[4] Tijerina-Sáenz Alexandra.[1]

1 Universidad Autónoma de Nuevo León, Facultad de Salud Pública y Nutrición, México. 2 Instituto Tecnológico de Sonora, Departamento de Sociocultural, México. 3 Universidad Autónoma del Estado de Hidalgo, México. 4 Universidad de Ciencias y Artes de Chiapas, Facultad de Ciencias de la Nutrición y Alimentos, México.

Citation: Ramirez López E., Puente Hernandez D., Negrete Lopez N.L., Serna-Gutierrez A., Calderón-Ramos Z., Omaña-Covarrubias A., Flores-Guillen E. Tijerina-Sáenz A. (2018) Comparison of perceived weight as ideal against ideal body weight formulas and body mass index of 22 kg/m² in young adult women. Revista de Salud Pública y Nutrición, 17(1), 7-15.
Editor: Esteban G. Ramos Peña, Dr. CS., Universidad Autónoma de Nuevo León, Facultad de Salud Pública, Monterrey Nuevo León, México.

Competing interests: The authors have declared that no competing interests exist.
DOI: https://doi.org/10.29105/respyn17.1-2
Recibido: 17 de abril 2018; **Aceptado:** 2 de mayo 2018
Email: erik.ramirezl@uanl.mx

COMPARISON OF PERCEIVED WEIGHT AS IDEAL AGAINST IDEAL BODY WEIGHT FORMULAS AND BODY MASS INDEX OF 22 KG/M^2 IN YOUNG ADULT WOMEN.

Ramirez López Erik.[1] Puente Hernandez Debbie.[1] Negrete Lopez Nohemi Liliana.[1] Serna-Gutierrez Araceli.[2] Calderón-Ramos Zuli.[3] Omaña-Covarrubias Arianna.[3] Flores-Guillen Elena.[4] Tijerina-Sáenz Alexandra.[1]

1. Universidad Autónoma de Nuevo León, Facultad de Salud Pública y Nutrición. 2 Instituto Tecnológico de Sonora, Departamento de Sociocultural, México. 3 Universidad Autónoma del Estado de Hidalgo 4. Universidad de Ciencias y Artes de Chiapas, Facultad de Ciencias de la Nutrición y Alimentos, México.

ABSTRACT

Introduction: Formulas of ideal body weight (IBW) including the body mass index (BMI) of 22 kg/m^2 are used under the assumption to provide a healthy weight. **Objective:** We compare the perceived ideal body weight (PIBW) with the calculated IBW by formulas and the BMI of 22. **Methods:** We recruited 705 women (20-25 y). Six common formulas and 2 published equations by our team were used. **Results:** Group regression analysis determined that including the frame size improves the agreement of formulas of Robinson et al, Hammond and Hamwi with the PIBW ($p>0.05$). Individually, the concordance analysis (higher % of differences <2 kg: PIBW - IBW by formula), determined that for a measured BMI <20, only the Faspyn 1 formula needs to be adjusted by frame size; while Robinson et al, Hammond, Tokunaga (BMI of 22), Faspyn 2 (BMI of 22) and Broca, are equivalent with the PIBW in different intervals of BMI. **Conclusions**: According to the BMI perceived as overweight (23.8 kg/m^2) and perceived as ideal (21.1 kg/m^2), caution is suggested when using the IBW formulas for BMI of 22 as a diagnosis. The IBW formulas and BMI of 22 does not necessarily represent a desirable or aesthetic weight. **Key words:** ideal body weight formulas, perceived ideal body weight, BMI of 22.

RESUMEN

Introducción: El peso ideal calculado con fórmulas (PIF) y con el índice de masa corporal (IMC) de 22 kg/m2 se emplea bajo el supuesto de proporcionar un peso saludable o estético. **Objetivo:** Comparar el peso percibido como ideal (PPI) contra el PIF y del IMC de 22. **Métodos:** Se reclutaron 705 mujeres (20-25 años). Empleamos seis fórmulas comunes y 2 publicadas previamente. **Resultados:** El análisis de regresión grupal determinó que incluir la complexión corporal mejora la concordancia de las fórmulas de Robinson et al, Hammond y Hamwi con el PPI ($p>0.05$). Individualmente, el análisis de concordancia (porcentaje mayor de diferencias <2 kg: PPI-PIF), determinó que para un IMC <20 kg/m^2 solo la fórmula de Faspyn 1 debe ajustarse por la complexión corporal, mientras que las fórmulas de Robinson et al, Hammond, Tokunaga (IMC de 22), Faspyn 2 (IMC de 22) y Broca, son equivalentes con el PPI en diferentes intervalos de IMC. **Conclusiones:** de acuerdo con el IMC percibido como sobrepeso (23.8 kg/m^2) y percibido como ideal (21.1 kg/m2), las fórmulas de peso ideal y el IMC de 22 deben ser usados con precaución en el diagnóstico de peso ideal ya que no necesariamente representan un peso deseable o estético. **Palabras Clave:** fórmulas de peso ideal, peso corporal ideal percibido, IMC de 22.

Introduction

People use the internet or applications to know their ideal body weight (IBW) and maintain an aesthetic figure. Also, professionals refer to IBW formulas or body fat analyzers (Tanita® and Inbody®) that employ the BMI of 22 (kg/m^2) to suggest a weight that is assumed as healthy and thus establish the objectives of the gain or loss of fat mass or nutritional risk (Bouillanne et al., 2005). There are more than a dozen of IBW formulas and some, such as the proposed by Robinson were generated from tables of the Metropolitan Life Insurance Company of 1959 or MetLife (Shan, Sucher & Hollenbeck, 2006). Robinson et al, as others, proposed a formula to calculate a dose of medication for patients. Other formulas, such as Hamwi, derived from empirical observations (Ramírez, Negrete & Tijerina, 2012), or as in the case of the formula of Broca, from a specific group of soldiers (Rössner, 2007).

The BMI of 22 was observed by Tokunaga, et al (Tokunaga et al., 1991), as an average value of BMI related to low mortality in Japanese population. Similarly, the IBW formulas only provide a punctual weight that represents the average of a group of medium frame size. Therefore, the BMI of 22 and the IBW formulas should be employed to be compared against an average population and not to suggest an individual weight. A study in Australian women 20 to 29 years old (Crawford & Campbell, 1999), reported that 28 per cent of them considered their ideal weight below the BMI <20; while the BMI considered as overweight was 23.7.

The body weight considered or perceived as ideal (PIBW) is the one that the patient wishes to have or that a person would feel better. This is a weight that an individual could find more familiar. Studies reviewed have only compared the IBW formulas among themselves or with the BMI of 22 kg/m^2 (Shan et al., 2006; Pai & Paloucek, 2000). Others compared the perception of an ideal figure based on images (Craig & Caterson, 1990). It is therefore not clear the agreement between the PIBW and the calculated IBW by formulas and BMI of 22. The objective of this study was to examine if the PIBW is in agreement compared to the calculated IBW by formulas and BMI of 22 in four intervals of BMI. Additionally, it was proposed to investigate: 1) whether including the body frame improves the group and individual agreement between the PIBW and the calculated weight with the IBW formulas, and 2) describe which BMI value is considered as overweight and which is considered ideal in the study group. The present study compares common IBW formulas and others recently proposed by our team, arising from height-weight tables for U.S and Mexican population (Ramírez et al., 2012).

Materials and Method

Design of Study and subject

For the purpose of carrying out the study we followed the recommendations of the Helsinki Declaration and the adoption of the Ethics Committee of the School of Public Health and Nutrition (Faspyn). This is a multi-centered descriptive study involving 4 schools of nutrition in four regions of Mexico: south (Chiapas); center (Hidalgo); northeast (Nuevo Leon) and northwest (Sonora). Women interviewed were 20 to 25 years (with a maximum BMI of 27.9) without cultural relationship with any indigenous group. The subjects were approached and invited to participate in public spaces such as shopping malls of middle socioeconomic level. The sampling was for convenience, with the aim of recruiting intentionally 200 subjects from each of the Nutrition schools. It was established to recruit from a single gender and an age range of 20 to 25 years to prevent the covariance by effect of gender and age. It has been suggested that in this age range is possible to have a reference weight for life (Kuczmarski & Flegal, 2000; Casillas & Vargas, 1980). All the anthropometric measurements and questionnaires were conducted during 2015 by nutritionists within the clinics of the participating schools. A general medical questionnaire was used to determine the health status of subjects, and to discard any pathology or the use of medications that could alter the weight or body composition in the previous three months. We excluded those patients who reported a loss of voluntary or involuntary weight greater than 2 per cent of their usual weight in the last week (Width & Reinhard, 2008). No blood samples were collected and neither blood pressure was measured to determine any cardiovascular risk factor.

Anthropometric measurements and ideal body weight (IBW) formulas

To use the IBW formulas we measured weight, height and elbow breadth by standardized

technicians (Lohmann, Roche & martorell, 1988). The frame size was established with the frame size index 2 from Frisancho (1990). Popular IBW formulas were used as well as two formulas developed by our team, which were previously described in detail (Ramírez et al., 2012; Table 1).

Table 1. Ideal body weight formulas used to be compared to the perceived ideal body weight.

Author	Ideal body weight (IBW) formula
Faspyn 1, 2012	IBW kg = (0.587 × height) + (0.631 × sex) – 39.3
Faspyn 2, (BMI 22) 2012	IBW kg = (0.747 × height) – 63.074
Hammond, 2000	Men: IBW kg = (height – 150) × 1.1 + 48 Women: IBW kg = (height – 150) × 0.9 + 45
Tokunaga et al, (BMI 22) 1991	IBW kg = 22 × height m^2
Robinson et al, 1983	Men: IBW kg = (height – 152) × 0.75 + 52 Women: IBW kg = (height – 152) × 0.67 + 49
Hamwi, 1964	Men: IBW kg = (height – 152) × 1.1 + 48 Women: IBW kg = (height – 152) × 0.9 + 45
Lorentz, 1929	Men: IBW kg = (height – 100) – [(height – 150) / 4 + (age – 20) / 4] Women: IBW kg = (height – 100) – [(height – 150) / 4 + (age – 20) / 2.5]
Broca, 1871	IBW kg = height – 100

Note: sex: female = 1, male = 2; age: years; height: cm, unless otherwise indicated.

Briefly, the Faspyn 1 formula is based on data from the Mexican population of 20 to 25 years. The Faspyn 2 formula was calculated on the basis of the BMI of 22 and according to tables published in the Dietary Guidelines for Americans 2010 (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010), which are a modification of the tables from MetLife (Kuczmarski & Flegal, 2000). The adjustment was made of ± 10 per cent from the calculated weight by each formula according to the frame size of each subject (subscript "adj").

Weight perceived as overweight and ideal

The participants were asked 1. – Ideally, how much would you like to weigh at the moment? 2.- In your opinion, what is the most you could weigh and still not consider yourself overweight? These questions were based on the questionnaire applied by Crawford and Campbell (1999). With these two questions, the questionnaire was piloted in 50 women to evaluate the inconsistencies of being self-administered. The weight reported by women was rounded in kg. The calculation for their BMI perceived as ideal (BMIpi) and BMI perceived as overweight (BMIpo) was done as follows:

$$BMI_{PI} = \frac{\text{Weight perceived as ideal Kg}}{\text{Current height m}^2}$$

$$BMI_{Po} = \frac{\text{Weight perceived as overweight Kg}}{\text{Current height m}^2}$$

Statistical Analysis

The inferential statistic was made using the software MedCalc version 13.3. (MedCalc Software BVBA, Ostend, Belgium). The first analysis consisted on comparing the average of the current BMI vs. the BMIpi with a t-test for dependent samples. Between these two variables, we analyzed the strength of the linear relationship with the Pearson correlation test. The group and individual agreement from the weight calculated with the IBW formulas and BMI of 22 with the PIBW was examined respectively by regression analysis and concordance tests. With the regression method of Passing & Bablock (1983), the presence of systematic and proportional differences was evaluated. With this method, the result does not depend on the allocation of one method or the other to X or Y. Systematic differences were determined if the intercept A, was $\neq 0$. With this, we test whether a method consistently presents positive or negative differences compared with another one. If there is a consistent bias, the differences can be adjusted from the subtraction of the mean of the differences of the other method. The proportional differences were established if the slope B was $\neq 1$. Unlike the systematic differences, the proportional differences indicate a direction, and may be more extensive throughout the range of measurements.

The agreement between the calculated weight with the IBW formulas and the BMI of 22 against the PIBW was determined with the method of Bland & Altman (1999). The analysis consists on calculating the differences between two methods (PIBW – IBW formula) and graphic them against the average of their measurements (PIBW + IBW formulas / 2). The limits of agreement of ± 2 standard deviations indicate what size is the extent of the differences between the two methods in 95% of

the evaluated cases. If the differences are very wide, the researcher may decide to accept or not a new method or its equivalent due to the clinical implications, such as the validation of blood pressure devices. Other limits of agreement can be also established a priori according to the researcher. As criteria for selecting the formulas with more individual agreement, we established those having the largest number of subjects (%) with differences ≤ 2.0 kg regarding the IBW by formula. This simple method, non parametric, is suggested by Bland and Altman and applied by the British Society of Hypertension for the validation of digital blood pressure cuffs (Bland & Altman, 1999). The limit of 2 kg was taken on the basis of 1.5 kg, which represents the maximum day-to-day variation of individual body weight (Robinson & Watson, 1965). The % of subjects with differences ≤ 2.0 kg (IBW formula - PIBW) was analyzed in 4 ranges of BMI: < 21 (normal lower range and moderate thinness); 21.0 to 22.9 (normal range); 23.0 to 24.9 (normal upper range) and 25.0 to 27.9 (overweight). The intervals are based on additional cut-off points of BMI suggested by the WHO (World Health Organization, 2006.).

Results

There were recruited 750 subjects, in which 25 were excluded due to incomplete data or anthropometric measurements and 20 with height <152 cm. The response rate of participation was of 98%. In the total sample, the age was 22 ± 1.4 years, and the index of frame size 2 was 36.1± 2.9. The current BMI was 22.3 ± 3.0 and BMI perceived as ideal was 21.1 ± 1.8 (difference -1.2: p<0.001). Both variables had a positive lineal correlation (r = 0.80; p <0.001).

Agreement of perceived ideal body weight adjusted by frame size and the ideal body weight by formula in the total sample

In the entire sample of study, when the IBW by formula was not adjusted by the frame size, systematic differences were observed in all the IBW formulas respect to the PIBW (Table 2). The IBW formulas adjusted by frame size in agreement with the PIBW were Robinson, Hammond and Hamwi, without systematic or proportional differences (p >0.05). However, in general, when the formulas were adjusted or not by body frame, there were differences of -10 to +16 kg against the PIBW.

Table 2. Comparison of the perceived ideal body weight (PIBW) versus the estimated weight with several ideal body weight (IBW) formulas, adjusted (adj) or not by frame size.

		IBW_{adj} – PIBW, kg				IBW – PIBW, kg	
Formula	Mean ± DE	Mean of the Difference	Limits of agreement 95%	Formula	Mean ±	Mean of the Difference	Limits of agreement 95%
$Robinson_{adj}$	53.7 ± 4.9	-0.7	-11.9 to 10.0	Robinson	54.6 ± 3.5	0.2*	-8.9 to 9.3
$Hammond_{adj}$	53.4 ± 5.7	-0.9	-11.7 to 9.8	Hammond	54.3 ± 4.7	-0.9*	-11.7 to 9.8
$Tokunaga_{adj}$ (BMI 22)	55.7 ± 5.2	1.3*	-10.0 to 12.1	Hamwi	52.5 ± 4.7	-1.9*	-12.8 to 8.1
Faspyn 2_{adj} (BMI 22)	56.7 ± 3.9	2.3*	-10.0 to 12.2	Faspyn 1	55.5 ± 3.0	1.1*	-9.4 to 10.6
Faspyn 1_{adj}	52.0 ± 4.8	-2.4*	-14.0 to 8.5	Tokunaga (BMI 22)	56.6 ± 3.7	2.2*	-8.3 to 11.9
$Hamwi_{adj}$	51.7 ± 5.7	-2.7	-14.1 to 8.0	Faspyn 2 (BMI 22)	56.7 ± 3.9	2.3*	-8.3 to 12.0
$Lorentz_{adj}$	57.5 ± 5.5	3.1*	-8.5 to 14.1	Lorentz	58.5 ± 3.9	4.1*	-6.6 to 13.8
$Broca_{adj}$	58.9 ± 7.8	5.0*	-6.4 to 16.4**	Broca	60.4 ± 5.2	6.0*	-4.0 to 4.30

Abreviations: IBM: ideal body weight; PIBW perceived ideal body weight.
Note: n = 705. The formulas were sorted from lowest to highest average of the differences.
*Indicates systematic differences p< 0.05,
** indicates proportional differences p< 0.05.

Agreement of the perceived ideal body weight adjusted by frame size ideal and the body weight by formula at different intervals of BMI

When the study sample was divided into the different intervals of established BMI, within each one, we selected the formulas with higher percentage of cases with differences <2 kg between the calculated weight with the IBW formulas and the PIBW (Table 3). The formula set by frame size of the Faspyn 1_{adj} was in agreement with the PIBW when the BMI is <21.0.

Table 3. Selection of ideal body weight formulas with higher % of cases with differences ≤ 2 kg compared to the perceived ideal body weight.

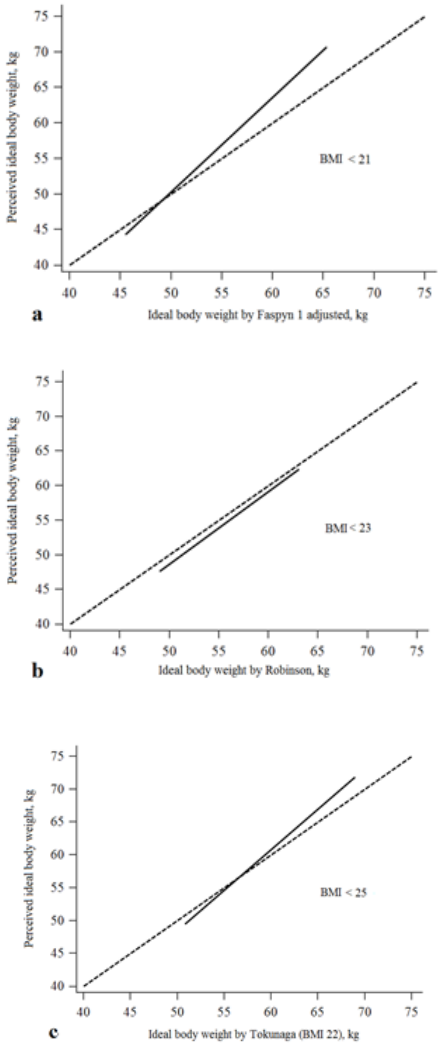
BMI interval and formula	% of cases with differences ≤ 2.0 kg (IBW by formula – PIBW)	Mean of the differences, kg
BMI <21.0 (n= 226)		
Faspyn 1_{adj}	50	-0.2
Hamwi	32	1.8
BMI 21.0 to 22.9 (n= 164)		
Robinson et al.	51	1
Hammond	50	0.6
BMI 23.0 to 24.9 (n= 145)		
Tokunaga et al (BMI 22)	57	0.3
Faspyn 2 (BMI 22)	56	0.4
BMI 25.0 to 28.0 (n= 170)		
Broca	47	0
Lorentz	36	-1.8

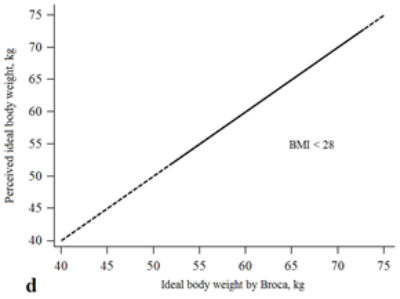
Note: Faspyn 1_{adj}; adjusted formula by frame size; ± 10% if frame size is small or large.
IBW: ideal body weight; PIBW: perceived ideal body weight.

The formulas of Robinson and Hammond were in agreement with the PIBW when the BMI is between

21.0 and 22.9. When the BMI of the participants is between 23.0 and 24.9, the formulas of Tokunaga and Faspyn 2 correspond best to the PIBW. Finally, the formula of Broca was in agreement when the BMI was between 25.0 and 28.0. All the selected formulas had systematic differences in the different intervals of BMI observed ($p < 0.05$). No formula presented proportional differences against the PIBW ($p > 0.05$; Figs. 1 a, b and c).

Figure 1. Passing and Bablok regression of perceived ideal body weight (PIBW) and the ideal weight estimated with several formulas (IBW) in different ranges of BMI (n= 705).





Each graph shows the line of identity or reference line (---) and the regression line (—) between the PIBW and the calculated with an IBW formula. (a) Faspyn´s Formula 1 adjusted by frame size (n=226); (b) Robinson´s et al. formula, without adjustment by frame size (n=164); c) Tokunaga´s formula (BMI 22) without adjustment by frame size (n=145); d) Broca´s formula without adjustment by frame size (n=170). All show systematic differences $p < 0.05$ but no proportional differences $p > 0.05$.

Body weight perceived as overweight and ideal.

The BMI considered as overweight was 23.8 ± 2.7. Those who believe a BMI ≥22.0 as overweight were 73.0%. The BMI perceived as ideal was 21.1 ± 1.8. Those who perceive that their ideal weight is below the BMI of 22.0 were 68.6 %. Women who perceived that their ideal body weight is below the BMI <21 were 52.3%. Only 2.3% of women perceive their ideal weight between 25 and 27.9 of the BMI.

Discussion

In this study we asked if there was an agreement between the perceived ideal body weight (PIBW) and the calculated ideal body weight (IBW) by formula and the BMI of 22 in women of different ranges of BMI. In addition, we examined whether including the frame size improves the agreement between the PIBW and the calculated weight with the IBW formulas, also it was studied which BMI value is considered as overweight and which as ideal in the study group. To our knowledge there are no reports to which we can directly compare our results.

Agreement of perceived ideal body weight adjusted by frame size and the ideal body weight by formula in the total sample

In this study, we found that at a group level, adjusting by frame size improves the agreement between the PIBW and the calculated weight with the IBW formulas of Hammond, Robinson et al, and Hamwi. These formulas did not present proportional or systematic differences regarding the PIBW. However, it is remarkable that, even if they are not adjusted by the frame size, the formulas do not show proportional differences. Since they are maintained in a direction, it may be possible to correct the error by subtracting the mean of the differences. We did not find studies to directly compare our results. However, a study that compared the IBW formulas among them or with the BMI of 22 did not considered the adjustment of the frame size (Shan et al., 2006; Pai & Paloucek, 2000). Rookus, Burema, Deuremberg & Van der Wiel-Wetzelsels (1985) pointed out that the adjustment of the body weight by the frame size does not necessarily improve the suggestion of IBW using the tables from MetLife 1983. According to our results, this observation agrees with some formulas when compared to the PIBW. Another interesting result we found was that the formula of Robinson, without adjustment by frame size, had the lowest average value of difference (0.2 kg) with the PIBW. The Robinson formula was derived from the tables of MetLife 1959 where the frame size was arbitrarily defined by an examiner (Kuczmarski & Flegal, 2000). It is accepted that weight when calculated by formula, a 10 per cent of weight is subtracted for a thin frame size and a 10% is added for a robust frame size. This is done under the assumption of correcting weight due to the size of the skeleton, the height and body fat. The % of body fat could be lower for a tall person than that for a short person of the same weight. Likewise, percent of body fat would be lower for a person with a large frame size than for someone with a small frame size with similar height and weight. However, Rookus et al. (1985) also suggests that the use of the frame size might not improve the prediction of % of body fat.

The reason that formulas of Hammond and Hamwi improve the group agreement with the PIBW when they are adjusted by the frame size could be explained by their relationship more than by its methodological structure. Hammond is only the metric system version of the formula of Hamwi, although the first uses a lower limit of height (Pai & Paloucek, 2000). Regarding the BMI of 22, the formula of Tokunaga and Faspyn 2 showed systematic differences with or without adjustment by frame size (Table 2). Again, we did not find studies to directly compare our results. We believe there is little focus on the hypothesis of the agreement between the PIBW and the BMI of 22, because it assumes that both the IBW formulas as well as a BMI of 22 provide a healthy and similar weight to one same subject, regardless of which formula is used (Shan & Sucher, 2006; Pai & Paloucek, 2000). Also, it is wrongly assumed that the BMI of 22 is the average interval internationally accepted (18.5 to 24.9 kg/m^2), and that it is the "healthiest" and most aesthetic for any individual.

Agreement of the perceived ideal body weight adjusted by frame size and the body weight by formula at different intervals of BMI

The BMI of 22 represents an average weight associated with the lowest mortality and morbidity in Japanese population, of medium frame size, but it is not a value for individual use (Tokunaga et al., 1991). The BMI of 22 does not consider the differences or individual preferences of an ideal weight considering a current BMI <21 or between 23 and 24.9. To verify the foregoing, we divided the sample in 4 ranges of BMI (<21, 21-22.9, 23-24.9 and 25-27.9) and compared the IBW formulas and BMI of 22 against the PIBW adjusted and not by frame size.

In this study, we demonstrate that at the individual level, including the frame size, improves the agreement between the PIBW and the calculated weight with the $\text{Faspyn}_{\text{adj}}$ formula, which was the only one that showed differences <2 kg in 50% of cases when the BMI was <21; while the second with most agreement was Hamwi, with only 32% of the differences <2 kg (Table 3). Figure 1 (a), verifies that the relationship between the PIBW and the IBW Faspyn 1 formula is linear, and presents no proportional error. A study that compared the IBW formulas vs. the tables of the MetLife reported that women of lower height had a BMI close to 20 kg/m^2, and that the formula of Hammond adjusted better to these women (Shan et al., 2006). In our case, the Faspyn 1 formula was the only in agreement with

the PIBW to a current BMI <21; this is, possibly for being specific to the population. The formula is based on Mexican tables (Casillas & Vargas, 1980) that have an average BMI of 19.8 for a thin frame size and 21.7 for a medium frame size. In addition, they include height from 142 cm up to 170 cm. The formulas of Hammond, Robinson and Lorentz can only be used in women with height ≥ 150 cm. In fact, to carry out the comparison of all the formulas, 20 women whose height were smaller than 152 cm were eliminated.

Evidence that different formulas correspond best with the PIBW at different intervals of BMI is supported by formulas of Robinson, Tokunaga (BMI 22) and Broca, without adjusting by frame size, which are those with the higher % of differences below <2 kg (between 47 and 56% of cases; Table 2). In Figures 1 b, c, and d, it is noted that the above formulas do not present proportional differences with the PIBW, although systematic, but that can be corrected by subtracting the value of the bias of the individual calculation. The formulas of Hammond and Faspyn 2 (BMI 22) are also in agreement respectively with Robinson and Tokunaga (BMI 22). The Faspyn 2 formula is based on the tables of the Dietary Guidelines for Americans (2010), which are a modification of the tables from MetLife in 1983 (Width & Reinhard, 2008). Another notable finding is that the formula of Broca is in agreement with the PIBW when BMI is between 23 and 24.9. Shah et al (2006) reported that for tall women, the ideal body weight according to formulas coincides with the BMI of 25 from the tables of MetLife. On the other hand, it is well known that the BMI is dependent on the height and that the formula of Broca by definition based its calculation on the height of a subject (Ramírez et al., 2012).

Body weight considered as overweight and ideal

This study provides evidence on women 20 to 25 years considering themselves as overweight in a BMI of 23.8 kg/m^2. Our study coincides with the BMI of 23.7 considered as overweight in Australian women 26 to 29 years (Crawford & Campbell, 1999). Other studies reported in women BMI limits of 26 to 27 (Craig & Caterson, 1990; Bhanji, Khuwaja, Siddiqui, Azam, & Kazmiet, 2011). However, they have contemplated ages from 20 to 59 years. It has been suggested that the greater the age or level of overweight, women perceive their ideal weight as higher and give it less relevance (Crawford & Campbell, 1999; Donath, 2000; Bhanji et al., 2011). In the present study, we observed a strong linear correlation between the current weight and the ideal body weight (r= 0.80, p< 0001).

It was found that the weight perceived as ideal corresponds to a BMI of 21.1. This result is similar to the BMI of 22.7 considered as ideal in Australian women (Crawford & Campbell, 1999). Another important outcome is that 68.7 per cent considered their ideal weight below the BMI of 22. There is evidence that women of normal weight report their ideal weight close to their current one (Craig & Caterson, 1990). However, the concept of the ideal weight differs between populations and their aesthetic definition has varied at different times (Bonafini & Pozzilli, 20112). In the cultures of southern Asia and Africa, a BMI close to 27 is synonymous for better social status (Bhanji et al., 2011). In our study, only 2.3% of women perceive their ideal weight between 25 and 27.9 of the BMI.

Limitations of the study

This study presents a comparison of the IBW formulas with the PIBW that has not been reported to our knowledge. In addition, it considered the analysis between multiple ranges of BMI and a range of age that has been suggested as a reference (Kuczmarski & Flegal, 2000). On the other hand, although it is a multiregional population, the study results do not allow the researchers to make inferences to the general population. Likewise, data of reported weight (that women had before the evaluation) was not obtained, thus it was not known if women overestimated or underestimated their current weight. However, it has been observed that young women are more familiar with their usual and current weight, in comparison with older women and men (Craig & Caterson, 1990; Engstrom, Paterson, Doherty, Trabuls & Speer, 2003).

Conclusions

At a group level, the formulas in agreement with the PIBW are Robinson et al, Hammond and Hamwi. At an individual level, only the formula of Faspyn 1 adjusted by frame size is in agreement with the PIBW at a BMI <20. The formulas of Robinson et al, Hammond, Tokunaga (BMI of 22), Faspyn 2 (BMI of 22) and Broca without adjustment by frame size

correspond best with the PIBW at different intervals of BMI. According to the BMI perceived as overweight (23.8 k/m^2) and perceived as ideal (21.1 k/m^2), caution is suggested when using the IBW formulas and BMI of 22 as diagnostic values and to establish goals for the gain or loss of body fat. The IBW formulas or BMI of 22 does not necessarily represent the individual desirable weight or aesthetic weight in the entire range of 18.5 to 24.9 of BMI. For example, a woman with a current BMI of 19 would have to increase 8 kg to reach the weight that corresponds to a BMI of 22. Other studies should validate the IBW formulas and the PIBW in women at BMI levels of overweight and thinness with the use of clinical indicators associated with morbidity. In addition, the results in males should also be evaluated.

References

Bhanji S, Khuwaja AK, Siddiqui F, Azam I, Kazmi K. Underestimation of weight and its associated factors among overweight and obese adults in Pakistan: a cross sectional study. BMC Public Health., 11(363): 1-8, 2011.

Bland JM, Altman DG. Measuring agreement in method comparison studies. Stat Methods Med Res., 8(2): 135-60, 1999.

Bonafini BA, Pozzilli P. Body weight and beauty: the changing face of the ideal female body weight. Obes Rev., 12(1): 62-5, 2011.

Bouillanne O, Morineau G, Dupont C, Coulombel I, Vincent JP, Nicolis I, Benazeth S, Cynober L, Aussel C. Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr., 82(4): 777-83, 2005.

Casillas L, Vargas LA. Height and weight charts for Mexican adults. Arch Invest Med., 11(1): 157-741980.

Craig PL, Caterson ID. Weight and perceptions of body image in women and men in a Sydney sample. Community Health Stud., 14(4): 373-831990.

Crawford D, Campbell K. Lay definitions of ideal weight and overweight. Int J Obes., 23(7): 738-45, 1999.

Donath SM. Who's overweight? Comparison of the medical definition and community views. Med J Aust., 172(8): 375-7, 2000.

Engstrom JL, Paterson SA, Doherty A, Trabulsi M, Speer KL. Accuracy of self-reported height and weight in women: an integrative review of the literature. J Midwifery Womens Health., 48(5): 338-45, 2003.

Frisancho AR. Anthropometric Standards for the Assessment of Growth Nutritional Status. Ann Arbor: The University of Michigan Press; 1990.

Global Database on Body Mass Index. BMI classification. United States of America: World Health Organization; 2006. Disponible en: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html.

Kuczmarski RJ, Flegal KM. Criteria for definition of overweight in transition: background and recommendations for the United States. Am J Clin Nut., 72(5): 1074-812000.

Lohmann TG, Roche AF, Martorell R. Anthropometric Standarization Reference Manual. Champaign: Human Kinetics Book; 1988.

Pai MP, Paloucek FP. The origin of the "ideal" body weight equations. Ann Pharmacother., 34(9): 1066-9, 2000.

Passing H, Bablok W. A new biometrical procedure for testing the equality of measurements from two different analytical methods. Application of linear regression procedures for method comparison studies in clinical chemistry, Part I. J Clin Chem Clin Biochem., 21(11): 709-720, 1983.

Ramírez E, Negrete NL, Tijerina A. El peso corporal saludable: definición y cálculo en diferentes grupos de edad. RESPyN., 13(4), 2012.

Robinson MF, Watson PE. Day-to-day variations in body-weight of young women. Br J Nutr., 19: 225-35, 1965.

Rookus MA, Burema J, Deurenberg P, Van der Wiel-Wetzels WA. The impact of adjustment of a weight-height index (W/H2) for frame size on the prediction of body fatness. Br J Nutr., 54(2): 335-42, 1985.

Rössner S. Paul Pierre Broca (1824-1880). Obes Rev., 8(3): 277, 2007.

Shan B, Sucher K, Hollenbeck CB. Comparison of ideal body weight equations and published height-weight tables with body mass index tables for healthy adults in the United States. Nutr Clin Pract., 21(3): 312-9, 2006.

Tokunaga K, Matsuzawa Y, Kotani K, Keno Y, Kobatake T, Fujioka S, Tarui S. Ideal body weight estimated from the body mass index with the lowest morbidity. Int J Obes., 15(1): 1-5, 1991.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2010. 7th Edition. Washington: U.S. Government Printing Office; 2010.

Width M, Reinhard T. The Clinical Dietitian´s Essential Pocket Guide. Philadelphia: Lippincott Williams & Wilkins; 2008.