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How well do you know your size? Accuracy of self-reported measures vs. BMI & waist to height ratio among Mexican women

(¿Conoces tu talla? Exactitud de las Medidas Auto Reportadas vs. IMC & la Relación-Cintura-Altura en Mujeres Mexicanas)

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Abstract

We evaluated the accuracy and the relationship of BMI calculated based on anthropometric measurements (BMIM) with three proxy measures: (1) BMI-reported (BMIR), (2) Figure Rating Scale (FRS), (3) Weight Status (WS). We also evaluated the degree to which these explain Waist-to-Height-Ratio (WHtR). The study was conducted with 280 female students in Mexico. Self-reported values, FRS and WS selections were elicited prior to anthropometric measurements. Although the majority of participants (69%) had normal weight, 40% of those were already at cardio-metabolic risk based on WHtR≥0.5. BMIR was the most accurate proxy for BMIM explaining 90% of its variance, FRS and WS explained 57% and 54% respectively. BMIR explained 42% of WHtR variance, other metrics explained less than 29%. Comparing the categorization into: obese, overweight, normal weight, and thin categories based on BMIM and WS, 27% of participants classified themselves incorrectly: the thin overestimated their weight, the overweight underestimated it, and both tendencies occurred within the normal weight group. Although participants in most cases correctly identified their weight and height this did not necessarily translate into knowing their weight category. The results are discussed in the context of information processing theories.

Key words: Obesity, BMI, Waist-Height, Women.

Abbreviations: **BMI** Body Mass Index, **BMIM** Measured BMI, **BMIR** Reported BMI calculated based on self-reported weight and height, **WHtR** Waist to Height Ratio, **FRS** Figure Rating Scale, **WC** Waist Circumference, **WS** Weight Status.

Resumen

Este estudio comparó el IMC calculado con base en las mediciones antropométricas (IMCM) con: (1) IMC-reportado (IMCR), (2) Escala de Siluetas (ES), y (3) Estatus de Peso (EP). También se evaluó como estas medidas se relacionan con el índice cintura-altura (CA). El estudio se realizó con 280 mujeres estudiantes en México. Los valores auto-reportados, la selección de ES y EP se obtuvieron antes de las mediciones antropométricas. El 69% tenía peso normal, sin embargo, de estas el 40% estuvo en riesgo cardio-metabólico con base en CA≥0.5. IMCR explicó el 90% de la varianza del IMCM; ES y EP explicaron el 57% y 54% respectivamente. IMCR explicó el 42% de la varianza del CA, otras métricas explicaron menos del 29%. Al comparar la categorización de las participantes en las categorías de peso con base en IMCM y EP, el 27% se clasificó incorrectamente: las delgadas sobreestimaron su peso, las sobrepesadas lo subestimaron y ambas tendencias ocurrieron dentro del grupo de peso normal. Aunque las participantes en la mayoría de los casos identificaron correctamente su peso y altura, esto no significó que conocían su categoría de peso. Los resultados se discuten en el contexto de las teorías de procesamiento de información.

Palabras clave: Obesidad, IMC, Cintura-Altura, Mujeres.

Abreviaciones: **IMC** Índice de Masa Corporal, **IMCM** IMC medido, **IMCR** IMC reportado según el peso y la altura auto-reportados, **CA** el índice Cintura-Altura, **EP** Estatus de Peso, **ES** Escala de Siluetas.

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Introduction

In Mexico the prevalence of overweight and obesity combined reached 75% among adults (Secretaría de Salud, 2018), yet many are unaware of their excessive weight, and do not take action to lose weight. According to a report from the Alliance for Food Health, Mexicans were not aware of the seriousness of the problem: 89% of those who were obese and 49% of those who were overweight did not recognize having such problems (Alianza por la Salud Alimentaria, 2013). Recent reports also state that only 9% of diagnosed obese and 6% of non-diagnosed obese correctly identify themselves as obese (Easton, Stephens & Sicilia, 2017). Although obesity affects the whole Mexican population, women are more often affected, with the obesity prevalence of 40% (Body Mass Index; BMI ≥30), vs. 31% among men (Secretaría de Salud, 2018). Age at which weight increase is the highest falls between adolescence (12-19 years old) and early adulthood (20-29) (Secretaría de Salud, 2012). We wanted to evaluate to what extent different self-reported body measures explain the BMI calculated based on anthropometric measurements in this most affected group. The differences can provide useful information for future health interventions: firstly, regarding the (in)accuracy of self-reports which are still commonly used; secondly, regarding the need for building awareness of own weight category prior to motivating weight loss.

Proxy Measures

Several measures can be applied to identify obesity and predict obesity related medical conditions, these include widely accepted BMI and waist-to-height ratio (WHtR), which has been getting attention as a more accurate predictor of obesity-related cardio-metabolic risks (Browning, Hsieh, & Ashwell, 2010; Schneider et al., 2010, Ashwell, Gunn, & Gibson, 2012; Ashwell, & Gibson, 2016). Both require knowing some anthropometric measurements: height and weight for BMI (calculated as weight (kg) / [height (m)]2), and height and waist for WHtR (calculated as waist circumference (cm) /height (cm)). As these are not always available, proxy measures are used, for instance reported BMI (BMIR), calculated based on self-reported height and weight, or Figure Rating Scales (FRS), for example nine body gender-specific figures increasing in size from thin [1] to obese [9], from which individuals identify a figure that best represents their current body size. Studies suggest high correlations between self-reported and measured BMI (Bulik, Wade, Heath, Martin, Stunkard, & Eaves, 2001; Stommel & Schoenborn, 2009, Craig & Adams, 2009). Regarding FRS, some studies show that these can explain 48%-59% of BMIM variance (Maupin & Hruschka, 2014; Kaufer-Horwitz, Martinez, Goti-Rodriguez & Avila-Rosas, 2006). Other way to obtain the information regarding one´s weight status is asking the question on weight self-perception. Although several studies provide information on accuracy of one or two self-reported metrics, to our knowledge the three have not been compared, allowing to identify the relationship between one´s anthropometric knowledge and weight status.

The primary objective of this study was to compare the accuracy of three self-reported metrics vs. measured ones. Specifically, we assessed the accuracy of three proxies (1) BMIR, (2) FRS, and (3) asking explicitly whether individuals consider themselves thin, of normal weight, overweight or obese, which we refer to as weight status (WS), to predict measured BMI (BMIM) in the sample of Mexican female students. The secondary objective was to evaluate the relationship of the three proxies with WHtR. We hypothesized that BMIR would be a more accurate predictor of BMIM vs. other two metrics. We discuss the findings in the context of information processing theories.

Information Processing Theories: schemas

We form self-schemas, “a mental representation of information with processing consequences” (Altabe & Thompson, 1996), based on past experiences, around aspects of life we consider important. Markus, Hamill, and Sentis (1987) distinguish body weight self-schema, indicating however that the importance we attach to body weight is not related to own weight, but to how we think about it. So how we process the information related to our weight will depend on whether we perceive ourselves obese or of normal weight, etc., and on the degree of body weight importance in our self-evaluation. The schematic way of thinking, especially in case of highly schematic individuals, gets activated in response to internal states and/or social situations (Corte & Stein, 2005), for instance presence of obese people, or trying on clothes. Other aspect, involved in processing information related to our weight, is amount of thinking, also called elaboration. Petty and Cacioppo (1986) indicate, that depending on a stimulus, we operate somewhere in between extensive elaboration and very low cognitive effort. The amount of cognitive response is determined by an individual’s ability and motivation to evaluate the information presented. Personal relevance of information, for instance information about our own weight and figure, motivates higher cognitive effort.

Method

Participants

Participants represented a convenience sample of 280 women between 18 to 27 years old (mean = 19.85, ±1.3), first and second year undergraduate students at Universidad Nacional Autónoma de México (UNAM), Mexico City, recruited at their study location. None had children.

Design

We conducted a correlational, cross-sectional study, with the measurements taken within the time interval of September 2016 and September 2017.

Anthropometric measurements

All participants had the following anthropometric measurements taken:

1. To calculate BMI height was measured with a stadiometer to the nearest half centimeter and weight with OMRON HBF-514C scale to the nearest 0.1 kg without shoes and any outerwear. To classify participants into BMI categories continuous BMIM was transformed into categorical variable based on World Health Organization's cut-points: <18.5 for underweight, <25 for normal, <30 for overweight, and ≥30 for obese.
2. To calculate WHtR waist circumference (WC) was measured with SECA 201 ergonomic circumference measuring tape to the nearest centimeter. To classify participants into "at risk" and "not at risk" a boundary value of 0.5 cm was applied, reported in recent studies as a sensible threshold, more sensitive than BMI as an early warning of obesity-related health risks for men, women, children and across different ethnic groups (Ashwell & Hsieh, 2009; Browning et al., 2010; Ashwell et al., 2012).

Proxies for anthropometric measurements

The following self-reported measures were obtained:

1. Reported BMI was calculated based on the answers to "How much do you weigh now?" and "What is your height?". To classify participants into BMI categories, continuous BMIR variable was transformed into categorical variable based on WHO's cut-points.
2. Body image perception was assessed via Figure Rating Scale: participants were presented with an image of nine female silhouettes from thin to obese and answered "Which out of nine body images represents your current body size?".
3. Weight status perception was assessed with the question "Do you consider to be: of very low weight, low weight, normal weight, overweight, or obese. First two categories were later combined into one category "thin" for comparability with BMIM categories.

The above listed proxies for anthropometric measurements represent widely and commonly used self-reported measures for assessing corporal weight category or figure (for instance for BMIR: Maukonen, Männistö, & Tolonen, 2018, for FRS: Bulik et al., 2001; Kaufer-Horwitz et al., 2006; for WS: Wang et al., 2017; Opie, Glenister, & Wright, 2019).

Procedure and Measures

During a pre-scheduled appointment at UNAM, participants were asked to fill in the computer assisted survey that included questions for proxy measures. The survey also included a question "When was the last time that you were weighed or weighed yourself?" with answers ranging from [1] within last 7 days to [6] more than 6 months ago. This question was added as first year students, as a part of their university admission process, have their height and weight measured during the first week of classes and we wanted to check if this had any influence on the study results, especially that the data was collected over a period of 12 months. They were also asked "Which range of BMI corresponds to normal weight?" with answers: <19; 19-25; 26-29; 30-34; 35+, and "do not know", to check their knowledge of BMI. After filling in the survey their anthropometric measurements were taken by a trained personnel. No measures were applied to filter for eating disorders. Written consent was obtained from every participant and data discussed here is anonymized. Participants did not receive any incentive to take part in the research.

Analysis

The variables: BMIR, FRS and WS were applied in linear regression one by one as independent variables to predict the dependent variables of: measured BMI and WHtR separately. Cross-tabulations were analyzed to compare categorizations across BMIM, BMIR and WS. Pearson and Spearman correlations were used to estimate relationships between variables. To estimate the accuracy of BMIR, FRS and WS for discriminating between overweight and non-overweight individuals, receiver operating characteristic (ROC) curves were computed. The difference between self-reported and measured BMIs, heights and weights were calculated (referred to as Error) by subtracting measured values from self-reported ones.

Results

Out of 280 interviewed 192 (69%) had normal BMIM and 72 (26%) BMIM≥25. Regarding WHtR 146 (52%) were at or above 0.5 threshold, these included 77 with normal BMIM, indicating possibility of cardio-metabolic risks within the group of normal BMIM. Out of 72 with BMIM≥25 only 4 had WHtR<0.5. Tab. 1 presents means for anthropometric measurements.

It is noteworthy that 226 participants (81%) indicated correctly the BMI range that corresponds to normal weight.

Table 1
Anthropometric measurements means and SD

			Weight (kg)		Height (cm)		BMIM		WC (cm)		WHtR (cm)	
BMI	N	%	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Thin	16	6%	43	*2.3*	156	*4.1*	17.6	*0.5*	67	*6.2*	0.43	*0.04*
Average	192	69%	55	*6.0*	159	*6.1*	21.7	*1.8*	76	*7.4*	0.48	*0.05*
Overweight	55	20%	69	*7.0*	159	*5.8*	27.2	*1.4*	87	*14.1*	0.55	*0.09*
Obese	17	6%	90	*8.4*	162	*5.4*	34.6	*3.7*	101	*10.1*	0.62	*0.07*
WHtR<0.5	134	48%	53	*7.8*	159	*6.0*	20.8	*2.3*	71	*8.7*	0.45	*0.05*
WHtR≥0.5	146	52%	65	*12.7*	158	*5.8*	25.7	*4.2*	87	*8.8*	0.55	*0.05*
Total	280	100%	59	*12.1*	159	*5.9*	23.4	*4.2*	80	*11.8*	0.50	*0.07*

Assessing proxy measures for BMIM

BMIR

Correlation between self-reported and measured values was very strong, for weight (r=0.97, p<0.001), height (r=.95, p<0.001), and BMI (r=0.95, p<0.001), which to some extent was expected taking into account that 186 participants (66%) were weighed within last month. BMIR explained 90% of BMIM variance. Model showed a good fit (F [1,278]=2558.80, p<0.001) and was significant (t=50.58, p<0.001, LCI=0.98, UCI=1.06, beta=1.02), allowing to calculate BMIM (y) for each BMIR value (x) based on the following equation: y=-0.55+(1.02)x.

Participants overestimated both their weight and height on average by 0.6 kg (±2.8), 0.8 cm (±1.9) respectively, the differences between reported and measured values were significant: (t (279) = -3.78, p<0.001) for weight, and (t (279) = -6.96, p< 0.001) for height. BMI resulted overestimated on average by 0.01 (±1.32), the difference was not significant. Average absolute value of Error for the total sample was 1.72 kg (±2.24) for weight, 1.26 cm (±1.63) for height, and 0.81 (±1.05) for BMI.

Cross-tabulation analysis indicated a strong relationship between self-reported and measured BMI: correct categorization into BMI groups for 261 participants (90%), Kappa 0.79, p>0.001. Among 29 (10%) misclassified: thin overestimated their BMI, those with BMIM ≥25 underestimated it. Within normal BMI group both under and overestimation occurred; yet the number of all misclassified in the total sample was relatively small and BMI Error was significant only in overweight and normal BMI groups.

FRS

The modal silhouette chosen was 4, corresponding to BMIM 22.7, which was somewhat lower than the actual mean BMIM of the total sample 23.4 (±4.2). BMIM and FRS correlation was strong (Spearman's Rho 0.77, p<.001). FRS explained 56.5% of the BMIM variance. Model showed good fit (F[1,278]=363.36, p<.001), and was statistically significant (t=19.06, p<.001, beta=2.49), allowing to calculate BMIM values (y) for each figure (x) based on the following equations: y=13.50+(2.49)x. Mean sample BMIMs adjusted well to the regression equations for the figures with mean BMIM for normal weight category, the bigger discrepancies were notable for thin and overweight, which were underrepresented in the sample. See Tab. 2 for distribution and average BMI measured and predicted per each figure selected. Based on mean BMIM, figure one represented thinness, figures from 2 to 4, normal weight, from 5 to 6 overweight and 7 obese (only one participant marked figure 7, none marked figures 8 & 9).

WS

Mean WS value was 2.37 (±.73), falling in-between normal weight and overweight group. Tab. 3 presents the participant distribution and average BMIM per each WS. Correlation between BMIM and WS was very strong (Spearman's Rho 0.81, p<.001). WS explained 53.8%, of the BMIM variance. Model showed a good fit (F[1,278]=325.96, p<.001), and was statistically significant (t=18.05, p<.001, LCI=3.41, UCI=4.25, beta=3.83), allowing to calculate BMIM values (y) for each WS value (x) based on the following equations: y=10.39+(3.83)x. Mean sample BMIM adjusted well to the prediction for normal weight group and overweight, for thin and obese the discrepancies were bigger as in the prediction based on FRS.

Cross-tabulation analysis indicated a moderate relationship between WS and BMIM categories (Kappa=0.52, p < 0.001), with 205 participants (73%) categorizing themselves correctly. Misclassification was significantly higher, compared with one based on BMIR, indicating that knowing one's own weight did not translate into awareness of own weight status. Out of 75 misclassified, 53 had normal BMIM, yet 73% of these considered themselves either overweight or underweight. (Those of normal BMIM who overestimated their weight status had significantly higher WHtR 0.52 vs. those correctly classified 0.47 (t =4.91, p<0.001). Misclassified thin (8) considered themselves

Table 2
Predicted and measured BMI for FRS

			BMIM			Predicted BMI		
FRS	N	%	Lower 95%CI	Mean	Upper 95%CI	Lower 95%CI	Mean	Upper 95%CI
1	4	1%	16.5	18.4	20.3	15.2	16.0	16.8
2	38	14%	18.9	19.4	19.9	17.9	18.5	19.1
3	50	18%	20.5	21.0	21.5	20.6	21.0	21.4
4	98	35%	22.2	22.7	23.2	23.1	23.5	23.8
5	59	21%	24.7	25.5	26.2	25.5	26.0	26.4
6	26	9%	27.7	29.5	31.4	27.8	28.5	29.1
7	4	1%	32.8	35.2	37.5	30.1	30.9	31.8
8	1	0%		39.4		32.3	33.4	34.5
9	0	0%						
Total	280	100%	22.9	23.4	23.9	23.0	23.4	23.7

Table 3
Predicted and measured BMI for WS

			BMIM			Predicted BMI		
WS	N	%	Lower 95%CI	Mean	Upper 95%CI	Lower 95%CI	Mean	Upper 95%CI
Low	23	8%	18.3	18.9	19.5	16.3	17.0	17.6
Average	153	55%	21.1	21.4	21.7	21.4	21.7	22.1
Overweight	88	31%	25.5	26.0	26.5	26.1	26.5	26.9
Obese	16	6%	31.5	33.9	36.3	30.5	31.2	32.0
Total	280	100%	23.7	24.6	25.5	23.0	23.4	23.8

of normal weight and those misclassified with BMIM≥25 (14), with exception of 4, underestimated their category. ROC curves were calculated to assess the accuracy of classifying women as overweight based upon their BMIR, a silhouette selection from FRS, and WS identification. The accuracy of classification of overweight individuals was high for all three proxies AUC>0.85, with BMIR providing highest value for AUC and FRS the lowest. See Tab. 5 and Fig 1.

Assessing the relationship between three self-reports and WHtR

Those with WHtR<0.5 had mean BMIM 20.8 (±2.3) vs. those with WHtR≥0.5 BMIM 25.7 (±4.2). The correlation between WHtR and BMIM was moderate 0.68, $p<0.001$. For FRS starting from body figure 5 mean WHtR was ≥0.5.

BMIR, FRS, & WS

Considering WHtR an important predictor of health risks, we evaluated the relationship between the same three self-reports BMIR, FRS, WS and WHtR. (Due to lack of reported WC we were unable to obtain self-reported WHtR, although anecdotal evidence suggests that awareness of WC is limited.) Out of three proxies, BMIR explained the greatest part of WHtR variance (41.6%), yet all three self-reports were relatively poor predictors when compared with variances explained for BMIM. The models for three proxies are compared in Tab. 4.

Figure 1
ROC for BMIR, FRS & WS for identifying overweight, BMI≥2

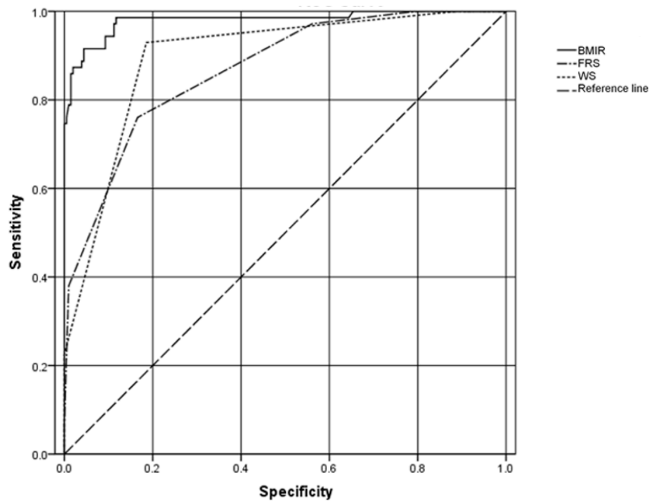


Table 4
Comparison of BMIR, FRS & WS as predictors of WHtR

	Variable (x)	Correlations	Explained Variance	Model fit	Sig	Equation
BMIR	BMIR	0.646, p<0.001	41.6%	199.523, p<0.001	t=14.125, p<0.001	y=0.222+(0.012)x
FRS	Silhouette	*0.637, p<0.001	28.7%	113.517, p<0.001	t=10.654, p<0.001	y=0.421+(0.031)x
WS	WS	*0.619, p<0.001	28.9%	114.595, p<0.001	t=10.705, p<0.001	y=0.358+(0.042)x

Note: Dependent variables is WHtR. *Spearman correlation. Model fit: F[1,278].

Table 5
Area Under the Curve and cut off points for BMIM & WHtR proxies

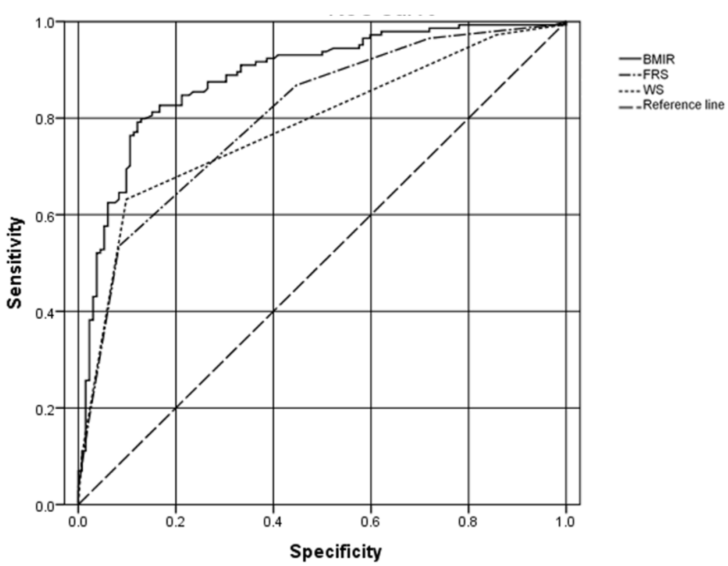
	BMIM					WHtR				
	AUC	LCI	UCI	p	Cut off	AUC	LCI	UCI	p	Cut off
BMIR	0.979	0.959	0.998,	< 0.001	24.7	0.883	0.843	0.923	< 0.001	22.5
FRS	0.868	0.821	0.914	< 0.001	4	0.805	0.754	0.856	< 0.001	4
WS	0.885	0.843	0.92	< 0.001	3	0.780	0.726	0.835	< 0.001	3

ROC curves were calculated to assess the accuracy of classifying women as at risk regarding WHtR cut off point ≥0.5, based on: their BMIR, FRS and WS. The accuracy of classification of individuals at risk was good for BMIR, and moderate for FRS & WS. See Tab. 5.

Discussion

The objective of the present study was to identify the most accurate predictor of BMIM, out of three self-repored measures: (1) BMIR, (2) FRS, (3) WS; and secondly, investigate the relationship between the three self-reports and

Figure 2
ROC for BMIR, FRS & WS for identifying WHtR≥0.5



WHtR, in the sample of female students. Estimator that explained the highest percent of BMIM variance was BMIR (90.2%) obtained with self-reported weight and height. High correlation of measured and self-reported values to some extent was explained by measuring students during their induction to the faculty, although similarly high correlations were found in Caucasian female populations: for height 0.94, weight 0.98 (n=181), height 0.96 and weight 0.93 (n=3556) (Bulik et al., 2001). Strong correlation 0.84 between BMIR and BMIM was also reported in the sample of Arabic origin students of both genders (n=308) (Radwan et al., 2019). Correlations for Mexican female population, age 18-76, were: 0.87 for height, and 0.94 for weight. For height, if only 18-59 age group was considered, the correlation was 0.94 (Osuna-Ramírez, Hernández-Prado, Campuzano & Salmerón, 2006).

FRS and WS explained 56.5% and 53.8% of BMIM variance respectively. Maupin and Hruschka (2014) obtained a model explaining 48% variance with FRS for women from low-resource setting in Guatemala, aged 18-64 (n=185). Kaufer-Horwitz et al. (2006) obtained 58.7%. value for Mexican Mestizo women: mainly school teachers or employees of public sector (n=1247), aged 20–69. Although explained variance of BMIM is significant, in none of the studies it reached levels explained with BMIR. We suggest that FRS is a perception measure rather than a proxy for BMIM.

With regard to WHtR, variance explained with BMIR, FRS, WS was quite low, still BMIR was the best predictor out of three with 41.7% variance explained. FRS and WC explained 28.7% and 22.1% respectively. Taking into account that WHtR was a better predictor of cardio-metabolic risks than BMIM, the self-reports did not provide good metrics for WHtR estimation. Although WHtR has been getting more attention as a better predictor of cardio metabolic health risks, the awareness of WC seems low. For instance, Cleveland Clinic Heart Health Survey (2016) reported that only 30% of Americans knew their WC: 41% of men and only 18% of women. In a not published survey with 168 Mexican doctors, conducted by the School of Social Psychology in 2018, 24% of interviewees did not know their waist circumference. Among those who provided information, 8% indicated their clothing size, instead of waist circumference. This points out to the need for building awareness of WHtR.

WHtR was proposed in 1995 as an alternative proxy for abdominal obesity metric (Browning et al., 2010), with the value of 0.5 as a sensible threshold across ages, genders and ethnicities (Browning et al., 2010). Mexican patient studies reported a relation between WC and risks associated with obesity like heart disease, diabetes, metabolic and hypertension risks (Fanghänel et al., 2011, Calleja & Sánchez, 2013; Domínguez-Reyes et al., 2017). Mexican Health Ministry established WC of 90 cm for men and 80 cm for women as a threshold indicating signs of risk, highlighting that WC ≤ 83 cm prevents diabetes and high cholesterol which act as triggers to heart attack, yet WHtR and related cut off point have not been officially established (Oliaz et al., 2006).

Regarding WS perception, beyond those whose BMIM matches their WS, we identified in the sample two tendencies: either under or overestimation of one's Weight Status vs. BMIM. Underestimation occurred in case of those with BMIM ≥25 and also among some of normal BMIM, and overestimation in those with BMIM <18.5 and among some of normal BMIM. In this study we have found that overestimation of Weight Status co-occurred with higher levels of WHtR, above 0.5 cm. This could suggest that the perception is actually not that incorrect and provides early warning signs. Data from this study is not sufficient to draw conclusions, bigger sample and longitudinal studies are required to understand the role of WC in WS perception.

Tendencies of Weight Status overestimation in case of BMIM <18.5; and underestimation among those with BMIM ≥25 were shown already in many studies (for example: Gregory, Blanck, Gillespie, Maynard, & Serdula, 2008; Choi, Bender, Arai, & Fukuoka, 2015; Muttarak, 2018). Among young adults of normal weight, it is not atypical to see both under and overestimation. For instance, one study among U.S. college students of normal weight BMI found that 12.9% of students had inflated body weight perception and 15.1% considered themselves to be thinner than they actually were. WS overestimation was more common in young women than men (Southerland, Wang, Richards, Pack, & Slawson, 2013). Similar trends were identified among Mexican teenagers (Hidalgo-Rasmussen & Hidalgo-San Martín, 2011).

Out of three proxies evaluated, WS did not add significant value as a predictor of BMIM to already established BMIR, yet it indicated the level of misperception regarding perceived weight category. Additionally, the results indicated that knowing one's weight did not mean knowing one's weight category. The percentage of those misclassified into BMIM categories based on Weight Status was 27% vs 10% based on BMIR. It is worth noting that the majority of interviewed (81%) knew BMI ranges, and correctly identified the normal weight BMI range.

The discrepancy between perceived WS and measured weight speaks to imperfect information processing with biases and errors, related to selectiveness in what we notice, learn, and remember. This selectiveness depends on internal cognitive structures which allow to process incoming information more efficiently, for instance information about one's appearance, including body size and weight. Not all give the same degree of importance to appearance and weight, yet all develop to some degree appearance-related schemas (Labarge, Cash, & Brown, 1998).

Regarding body weight information, girls typically reach adult height by age 15 (Rogol, Clark, & Roemmich, 2000), hence a 22-year-old female student would have 7 years with the same height, and repetitive weighing experiences, due to school-university environment, where this data is commonly collected. So weight and height, represent in this population typically an accessible and salient piece of information, easily retrieved from memory, without the need of elaborate processing. Regarding the meaning given to this information, as a part of the self-appearance schema, it is formed by the unique characteristics of the individual, including perception of own body weight, and also by the interaction with environment: norms, values, and ideals of the cultural context (Corte & Stein, 2005). Predominant cultural messages focus individual's attention on specific aspects of the self and accepted norms and ideals become the standards against which an individual is evaluated and defined.

In Mexico majority of adults is either overweight or obese, so a commonly encountered silhouette is rounder and the normal weight figure represents a minority. Additionally, the physical attractiveness stereotype promotes a strongly curved figure; in the stereotypes poll realized by Gabinete de Comunicacion Estrategica (2016) respondents acknowledged that men are more focused on women with curves and exuberant shapes. Trying on clothes, which used to serve as an external trigger to bring attention to one's weight, is no longer reliable due to common use of smaller size numbers for bigger size garments or application of uni-size. Maternal attitudes that also contribute to individual's assessment of physical-self in Mexico are biased towards rounder figure. Majority of mothers of 22-year-olds are between 40-69 years old, among these 92% have WC >80 cm (Secretaría de Salud, 2016), and the majority is overweight. It is the age range with highest obesity prevalence. Even if we consider peers as an important reference group, among 20-29 year-old women, 75% have WC >80 cm (Secretaría de Salud, 2016).

Above-mentioned tendencies explain the underestimation of Weight Status; when it comes to overestimation, this could be influenced by thin beauty ideals dominant in media targeted to women, which is not only the case in western cultures but also in Mexico (for instance Pérez-Lugoa, Gabino-Camposa, & Baile, 2016). Exposure to idealized bodies in media influences how women want to look (and, sometimes even how they think they look). Yet, there are individual differences in how women respond to viewing these images (Mills, Shannon, & Hogue, 2017) and differences in exposure time to media, thus media beauty trends do not affect all women equally.

Taking into account all personal and external factors that influence personal weight perception, even if the weight and height numbers are correctly retrieved from memory, they are subject to interpretation according to the above mentioned influences. Hence, even if a person knows the BMI range that corresponds to normal weight, this knowledge does not necessarily translate into identifying a corresponding Weight Status. Other aspect that may contribute to different interpretation of weight expressed inkilograms, vs Weight Status e.g. as obese, or overweight, is the degree of relevance and affect associated with the information. While retrieval of weight and height numbers from memory may require little elaboration, labeling oneself "obese" requires more involvement on cognitive and emotional level, especially if appearance and weight represent an essential part of one's self-concept.

Body weight misperception is not just a matter of semantics; both weight under- and overestimation have significant behavioral consequences. Overestimation is associated with unhealthy dieting and negative psychological consequences; on the other hand, undetected adiposity means no action taken to reduce the weight and possible health deterioration (Robinson, 2017).

This study was carried out with a convenience sample of female students, so it cannot be generalized to other populations. This study could benefit from a bigger sample, with equal representation of all weight categories, as in this study the group of normal weight participants was predominant.

Conclusions

In this study we examined different proxy measures (BMIR, FRS, WS) for measured BMI. High awareness of own height and weight within female student population supports the use of self-reported BMI as a proxy for measured BMI, more exact than Figure Rating Scale or Weight Status within this population. Moreover, this study indicates that knowing one's weight and height does not translate into knowing one's weight category, even for those familiar with BMI and its ranges, what was also found in earlier studies with other populations. The discrepancy between measured BMI and perceived weight category highlights the need for health interventions to assure weight category awareness prior to promoting weight loss. Additionally, we analyzed the relationship between BMIR, FRS, WS and WHtR. The self-reported measures explained only a relatively small portion of WHtR (42%-22%). We highlight the need for identifying proxies for WHtR and for promoting WC awareness, taking into account that WHtR is a better predictor than measured BMI for cardio-metabolic risks.

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