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Overweight/Obesity in University Students from Mexico: Comparison Using Different Indices

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Abstract

The goal was to compare body mass index (BMI), waist circumference (WC), waist to height ratio (WHtR), and relative fat mas (RFM), to identify the best predictor of overweight and obesity in university students from Mexico. This is a cross-sectional survey with 697 university students from northern and central Mexico (448 women, and 249 men aged 18 - 19 years). Data was collected during 2018. Overweight and obesity were calculated from those indices and for both, female and male students, the order of correlation between a pair of indices were WHtR *vs.* RFM > WHtR *vs.* WC > RFM *vs.* WC > WHtR *vs.* BMI > BMI *vs.* WC > RFM *vs.* BMI. It is concluded to use the WHtR and the RFM to better predict overweight and obesity in young Mexican university students.

Keywords

Overweight and Obesity, Anthropometry, Anthropometry Indices

1. Introduction

Excessive body weight leads to overweight and obesity (OW/O) which became an epidemic of the XXI century [1]-[4]. This condition is a public health threat for all countries and is related to non-communicable metabolic associated diseases, such as metabolic syndrome, cardiovascular diseases and diabetes; the last two are the first and ninth leading causes of death worldwide, respectively [5]. Among the countries with the highest prevalence of OW/O are Mexico (72.5%)

and the USA (71.0%), with the burden of this condition that impacts in quality of life and economic costs on individuals and governments [6].

Body Mass Index (BMI) is the standard approach to define if a person is overweight or obese, *i.e.*, it measures an individual's weight related to individual's height (weight/height^2, kg/m^2); even though, BMI does not account for body fat neither for gender, and does not represent the health of an individual [7]-[9]; however, after four decades of use BMI has proven to have several limitations, such that its inadequacy to determine fat distribution, and the outcome risks related to overweight/obesity, despite it correlates with several outcomes of disease [8] [10]. On the other hand, other used indices to determine OW/O are Waist Circumference (WC) [7] [11]-[13], Waist to Height ratio (W/HtR) [14]-[16], and a recent one the Relative Fat Mass (RFM) [9] [17].

Regarding WC many studies relate this parameter according to local [18], or international [19] [20] standards associated with the metabolic syndrome cluster of alterations; based on those different standards, WC varies accordingly. In the present study we used the proposal of Alberti *et al.* (2009) [19] and Ross *et al.* (2020) [20] of the values for WC, *i.e.*, ≥80 cm for women and ≥90 cm for men as central obesity cut-off points.

Relative Fat Mass is a recent proposal obtained after evaluation of 365 anthropometric indices, which includes height/waist circumference and also takes sex in account for the derived equation [9]. RFM has been validated for a north-west Mexican population with a small sample (n = 61 individuals total), aged 20 - 37 years-old [17].

The WHtR was proposed in the middle 1990s as a better indicator for the management of body weight [14]-[16], these authors opine that WC should be half of the stature being a very affordable screening approach to be healthy [21].

Then the aim of this communication is to compare the described indices in first year university student populations of Universidad Autónoma de Ciudad Juárez (UACJ), a northern university in the border line with the USA, and Universidad Nacional Autónoma de México (UNAM) at the center of the country.

2. Methods

2.1. Participants and Ethical Statement

The student communities were invited to participate in the project through an announcement, such that those students that responded were included. No exclusion was made since the goal was to evaluate the first year students coming to the university. The Healthy University Branch (UACJ) enrolled almost all students of the sample from Institute of Biomedical Sciences; while for FESI-UNAM ~70% students of nursing career were involved. The study is a cross-section survey from a UACJ sample that accounted 502 first-year university students (295 females, 207 males), and those from FESI-UNAM were 204 (158 females, 46 males), all of them aged 18 - 19 years. Students were informed about the objective of the study and signed an informed consent. Students were asked

to arrive to the university, either UACJ or FESI-UNAM, between 7 - 10 am. Waist circumference and height were recorded to the nearest 0.1 cm by means of a Seca wall stadiometer (model 208, Mexico City), and a metallic flexible anthropotape (Rosscraft, USA). Body weight was recorded to the nearest 0.1 kg using a digital Seca scale (model 700).

Even though the study involved anthropometric measurements only, the Institutional Ethics Committee approved the protocol, and anthropometric measurements were determined during 2018. Five female and four male students abandoned the study. Trained personnel from both universities collected reliable data as described [22] [23].

2.2. Statistical Analysis

Data base was analyzed for BMI, WC, RFM and WHtR; means ± SD are shown in Tables. Plots compare WHtR *vs.* RFM, WHtR *vs.* WC, RFM *vs.* WC, WHtR *vs.* BMI, BMI *vs.* WC, RFM vs. BMI. Student's *t* test for unpaired samples was used. *$p < 0.05$ among the different groups per index.

3. Results

Students were divided by sex and anthropometric determinations were made. As observed in **Table 1**, subgroups of female students were set according to weight and abdominal obesity; the sample population shows a wide variety and prevalence of the different phenotypes, ranging from underweight to obese, *i.e.*, from the total of 448 participants, 172 were considered within normal weight and waist circumference. When these subgroups were plotted using different pair of indices, the following order of best correlations were obtained: WHtR *vs.* RFM > WHtR *vs.* WC > RFM *vs.* WC > WHtR *vs.* BMI > BMI *vs.* WC > RFM vs. BMI (**Figure 1**).

Table 1. Prevalence of combinations of Body Mass Index Categories (BMI), Waist Circumference (WC), Waist to Height Ratio (WHtR), and Relative Fat Mass (RFM) in female university students (n in each category).

Women				
Groups (n)	BMI	WC	RFM	WHtR
Underweight without central obesity (20)	17.7 ± 0.4	67.8 ± 4.7	28.4 ± 3.0	0.42 ± 0.03
Normal weight without central obesity (172)	21.1 ± 1.7	72.5 ± 4.6	32.4 ± 3.2	0.46 ± 0.03
Normal weight with central obesity (67)	23.2 ± 1.4	83.8 ± 3.7	37.6 ± 1.8	0.52 ± 0.03
Overweight without central obesity (17)	26.8 ± 1.3	76.2 ± 3.4	34.9 ± 2.3	0.49 ± 0.03
Overweight with central obesity (117)	27.1 ± 1.4	87.3 ± 4.8	39.6 ± 2.0	0.55 ± 0.03
Obese without central obesity (1)	31	79	37.8	0.52
Obese with central obesity (54)	33.6 ± 2.9	99.4 ± 8.1	43.8 ± 2.4	0.62 ± 0.05

Overweight/obesity indexes: BMI (Body Mass Index), WC (Waist Circumference), RFM (Relative Fat Mass), WHtR (Waist to Height Ratio); data are the means ± SD of (n) individuals. n = 448 female university students.

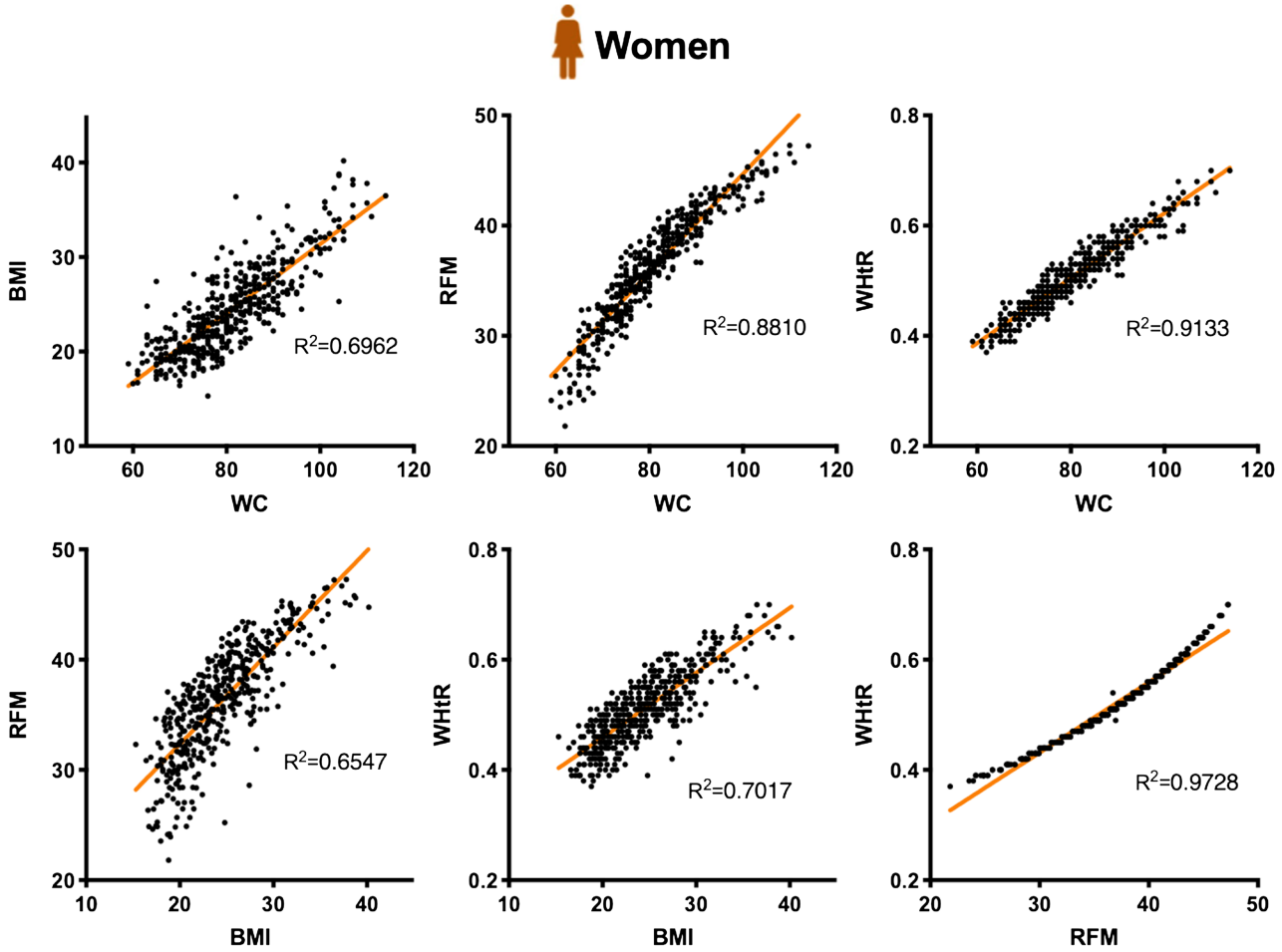

Figure 1. Female students were subjected to the following measurements: Body Mass Index (BMI), Waist Circumference (WC), Relative Fat Mass (RFM), and Waist to Height Ratio (WHtR). n = 448 female university students.

Table 2. Prevalence of combinations of Body Mass Index Categories (BMI), Waist Circumference (WC), Waist to Height Ratio (WHtR), and Relative Fat Mass (RFM) in male university students (n in each category).

Men				
Groups (n)	BMI	WC	RFM	WHtR
Underweight without central obesity (15)	17.7 ± 0.7	72.1 ± 3.2	15.6 ± 2.2	0.42 ± 0.02
Normal weight without central obesity (115)	22.1 ± 1.7	78.7 ± 5.5	20.3 ± 2.8	0.46 ± 0.03
Normal weight with central obesity (4)	24.2 ± 0.3	93.0 ± 2.1	25.1 ± 1.0	0.52 ± 0.01
Overweight without central obesity (38)	26.3 ± 1.1	85.4 ± 3.1	24.4 ± 1.9	0.51 ± 0.02
Overweight with central obesity (41)	27.8 ± 1.4	95.2 ± 4.0	27.5 ± 1.5	0.55 ± 0.02
Obese without central obesity (0)	-	-	-	-
Obese with central obesity (36)	33.8 ± 3.0	109.9 ± 8.4	32.1 ± 2.4	0.63 ± 0.05

Overweight/obesity indexes: BMI (Body Mass Index), WC (Waist Circumference), RFM (Relative Fat Mass), WHtR (Waist to Height Ratio); data are the means ± SD of (n) individuals. n = 249 male university students.

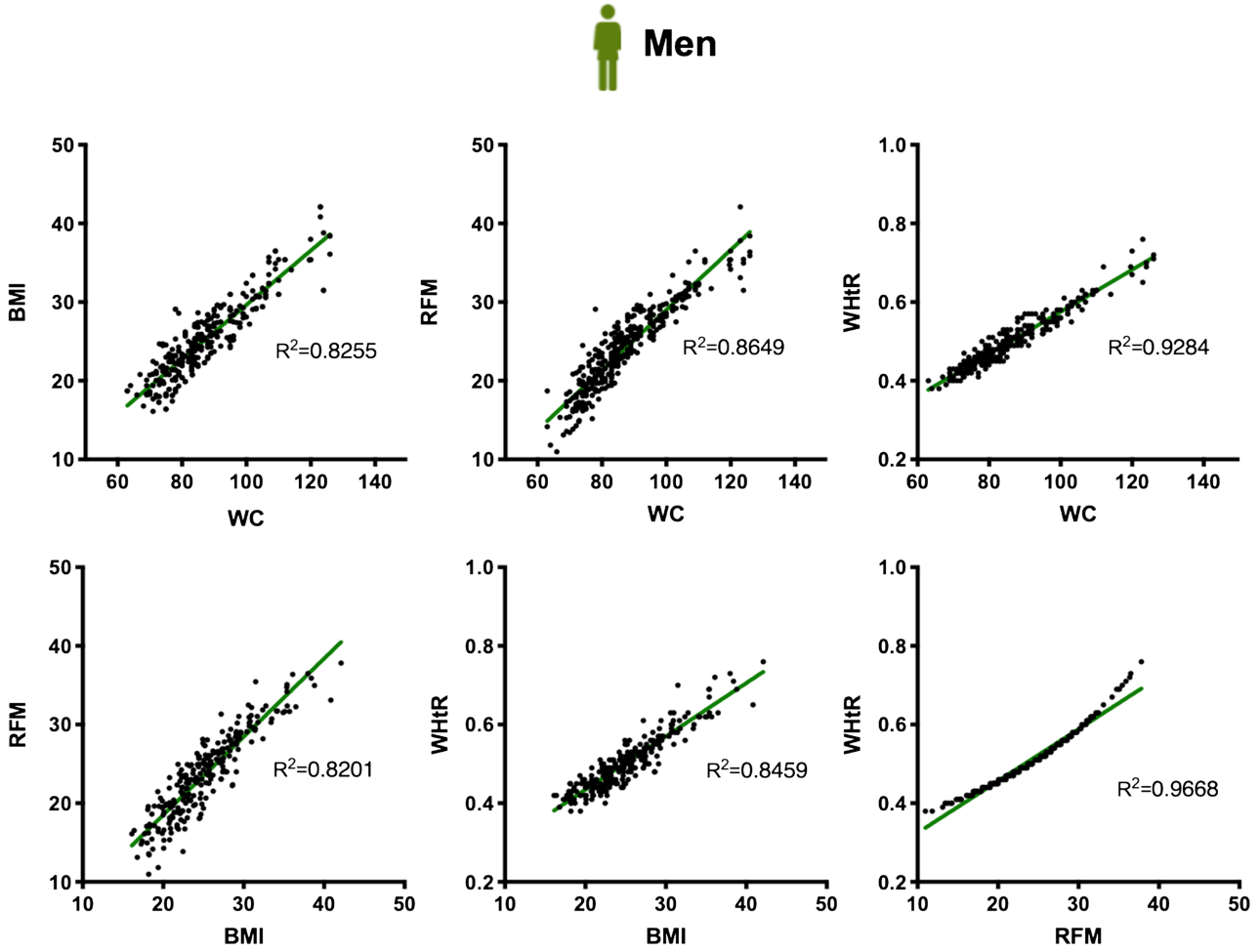

Figure 2. Male students were subjected to the following measurements: Body Mass Index (BMI), Waist Circumference (WC), Relative Fat Mass (RFM), and Waist to Height Ratio (WHtR). n = 249 male university students.

Regarding male students, a similar pattern was observed with the same range of phenotypes as in female students, but there was a lower number (249) of individuals, where 115 were considered within normal weight and waist circumference (**Table 2**). When these subgroups were plotted using different pair of indices, the following order of best correlations were obtained: WHtR *vs.* RFM > WHtR *vs.* WC > RFM *vs.* WC > WHtR *vs.* BMI > BMI *vs.* WC ≥ RFM *vs.* BMI (**Figure 2**).

It is worth to mention that no differences were observed when female, neither male students from each university were compared using the different indices (results not shown), such that we decided to include all of them in each analysis.

4. Discussion

Overweight and obesity account for ~2.6 billion persons worldwide [24], with a projection to be 3.0 billion in 2025, with more than 1.2 billion obese [24]. As noticed in several guidelines for the management of OW/O, the late outcomes of bearing these conditions are health impairment, stigmatization, diabetes, nonal-

coholic fatty liver disease, among others [25] [26]. In this regard, BMI is the most used index to determine this OW/O condition; however, other indices are proven to better determine OW/O in many studies so that it could be important to take them in account [9] [11] [15] [27]. In addition, all those indices relate OW/O to diseases outcome, such that it is not clear how the correlation between anthropometric indices is in a current open late teenage population (*i.e.*, 17 - 19 years old), since most of the studies involve wide age ranges [11] [12] [16] [20] [28] [29].

In this study an approach was made to determine anthropometric measures in young university students, and challenged their combinations to seek what pair of indices are the best correlated. Data showed that students entering university distributed in all possible phenotypes of weight and waist, in contrast to Bener *et al.* [29] and Janssen *et al.* [11] results, where their samples showed WC and BMI values according to NCEP-ATP III and IDF cut-off points, and Bener *et al.* did not separate by gender [29]; moreover, both studies involved people of 30 years and older. Also Janssen's report mentioned that 43% males and 48% females were normal weight and waist [11], while in this study sample 46% were males and 38% were females with that phenotype.

Regarding normal WC, studies had been focused on the use of NCEP-ATP III for the NHANES III survey, whose cut-off points are ≥88 cm for women and ≥102 cm for men, covered the 95th of the healthy women and men [12]; while the healthy women and men were included in a BMI range of 19.5 to 30 kg/m^2 for the same survey [26]. The current study using Alberti *et al.* [19] and Ross *et al.* [20] criteria showed that 210 out of 448 female students (~47%) had normal WC, including all phenotypes described in **Table 1**; whereas 168 out of 249 (~67%) male students had normal WC, including all phenotypes described in **Table 2**. This means that depends which index is used, some percentage of the population will be considered with a healthy WC. According to the WHtR index, a healthy waist is to be less than one half the height of the individual [14]-[16] [21], which in the present study fits about 47% of female students and ~52% of male students, that is coincident with WC in females but is a lower percentage for WC in males. When RFM was analyzed, the only study reported in Mexicans are from the northwest part of the country and accounted for 61 persons, both sexes, aged 20 - 37 years; that study validated RFM against dual-energy X-ray absorptiometry (DXA), and authors mentioned that it has a better correlation with DXA than BMI *vs.* DXA [17]. For the present study it is clear that the objective was to use anthropometry indices to have the best approach to determine OW/O, in a simple way as possible; then, it was obtained a rank order of fitness for the different pair of indices determined, which accounted as WHtR *vs.* RFM > WHtR *vs.* WC > RFM *vs.* WC > WHtR *vs.* BMI > BMI *vs.* WC ≥ RFM *vs.* BMI.

5. Conclusion

Our study led us to conclude that WHtR and RFM show the best correlations to

predict overweight and obesity in young Mexican university students.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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