Research Article
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Comparison of the body mass index (BMI) in physical education students, established by anthropometric, self-report and figure test techniques

Abstract

The purpose of the study was to compare the BMI according to different measurement techniques and to analyze differences between age and sex of Physical Education students. Type of descriptive research with a non-experimental cross-sectional research design. 107 students from Catamarca (Argentina) participated, 67 men (62.6%) and 40 women (37.4%) between 21 and 40 years old. Body weight (self-reported and real) will be reduced, to estimate the BMI the formula will be improved: models weight (kg) / height (m^2) and to determine the perception by figures, the 7 anatomical sheet of Montero will be taken. The real BMI of 24.59 kg/m^2 was established, self-reported BMI of 24.25 kg/m^2 and a perceived BMI by figure of 24.06 kg/m^2, 88.8% of the students are of normal weight. . The results determined significant differences of p<.001 in all the study variables between men and women. In the sample in general, significant differences were found between the real and self-informed height (p<.001) and between the real BMI with self-reported and with that perceived by figures (p<.05). The men turned out to be more effective in the perception of the figure and the women in the self-report with respect to the real BMI. Positive and significant correlations are presented between the real and self-perceived measurements in each of the variables, highlighting the real BMI with the self-reported BMI (r =915) and with the BMI perceived by figures (r =629) with significance. (p< .001). It is concluded that the BMI established by the techniques of self-report and perception by figures, underestimate the BMI measured by anthropometry, being the self-report technique the most effective of them, obtaining a high connection with the real BMI and with a high predictive value of estimation of the same.

Keywords: BMI, measurement, self-report, figure perception, university students

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Introduction

Young university students are a particularly vulnerable population group with particular characteristics. On the one hand, they are subject to changes typical of youth, and on the other, to sociological and cultural changes.[1] The body structure of the Physical Education student becomes vitally important because it will be relevant in their achievements in subjects that involve physical effort.[2] In addition to this, there is the nutritional vulnerability of these young people, whose diet is characterized by frequent skipping meals, intake of soft drinks, intake of fast food, and consumption of alcohol and/or energy drinks, which will affect body weight and your future health.[3]

The evaluation of body perception through the BMI is generally estimated through the use of different evaluation instruments, such as the self-report of weight and height and self-perception through the test of figures; although logically the determination of body mass by the anthropometric technique evaluated by a specialized person is the only truthful and precise;[4] although some authors, Davies et al.,[5] highlight a good concordance between direct and self-reported anthropometric measurements.[5] In the consulted bibliography, it was found that the accuracy of the self-reported BMI varies according to age,[6] gender,[7,8] socioeconomic characteristics,[9] sociodemographic characteristics,6 actual weight,[10] ethnic origin, and perceived body image.[11] Different authors suggest that online self-reported height and weight may be a valid method for collecting anthropometric data when direct measurements are not feasible,[5,12] however, anthropometric measures are subject to systematic reporting biases that can lead to differences between self-reported and measured height and weight.[6]

In general, weight is underestimated, while height is overestimated which leads to an underestimation of the BMI [1,9,13] and an erroneous classification in the BMI categories. Underestimation of the BMI derived from self-reported height and weight is generally prevalent in people who are overweight and obese.[10] The international literature has reported prevalence rates of dissatisfaction with body image among university students and that they are higher in courses where physical appearance is important, for example, in physical education careers, where high levels of dissatisfaction are even more common, which reflects the interest of these students in problems related to the body.[14] Therefore, the objective of this study was to compare mean values of weight, height and BMI according to different measurement techniques and to analyze the differences between age and sex of Physical Education students.

Material and methods

The type of research was descriptive, explanatory and applied, with a cross-sectional non-experimental research design. In this study, a total of 107 students between 21 and 40 years old participated; belonging to the Physical Education faculty of Catamarca (I.S.E.F.) and to the Bachelor's degree course in Physical Education of the

Faculty of Health Sciences of the National University of Catamarca (Argentina). The type of sample was non-probabilistic for convenience. The students who agreed to participate voluntarily signed an informed consent. To carry it out, the ethical considerations contemplated in the Declaration of Helsinki were met, taking all kinds of precautions to protect the privacy of the person who participated in the investigation and the confidentiality of their personal information. For the present work, personal data such as age and sex were taken into account; anthropometric data such as height and body weight (self-reported and actual). The measurement of weight and height was established in the ISAK methodology. To estimate the BMI, the formula was changed: weight (kg)/height (m^2). The cut-off points for the BMI classification were those established according to the guidelines of the World Health Organization. To determine the perception of body image, a sheet was drawn with 7 anatomical models for both sexes and with their respective BMIs (18, 22, 25, 27, 30, 35, 40), proposed by Montero.[15]

Data analysis was processed using the SPSS 25 program, determining arithmetic means, standard deviations, as well as absolute and relative frequencies. The Shapiro Wilk Goodness Test was performed to evaluate the normality of the variables, Student's T test for the differences in means for normal variables after checking the homogeneity of variances, according to significant means considering a lower alpha or Levene's test. . Differences equal to 0.05 were considered. Analysis of variance (ANOVA) was applied to study the relationships between categorical predictor variables and quantitative criteria variables (Classification of BMI for ages).

Results

The sample consisted of 67 male students (62.6%) and 40 female students (37.4%) with a mean age of 25 ±2. A real BMI of 24.59 kg/m^2 of the sample was established, a self-reported BMI of 24.25 kg/m^2 and a perceived BMI by figure of 24.06 kg/m^2. Therefore, we could categorize students according to the WHO criteria[16] in normal weight, both in the BMI measured anthropometrically (real) and in the self-reported and perceived by figures.

When the BMI analysis is carried out using the three techniques, real, self-reported and perceived by figures Table 1, students in general perceive themselves as taller and heavier, but with an underestimation of the BMI. When the analysis is discriminated according to the sex of the participants, the women perceive themselves to be taller, lighter, and with an underestimation of the BMI with all the techniques; in the case of men, on the contrary, they are perceived to be taller, heavier, presenting an overestimation of the BMI perceived by figure and underestimation with the self-report technique.

For the analysis of the students according to the ages, given the great disparity of ages that they presented, they were divided into groups, separating them every 5 years, forming group 1 those who were between 21 and 25 years old, group 2 those of 26 to 30 years, group 3 from 31 to 35 years and group 4 from 36 to 40 years. In all age groups Table 2, they perceived themselves to be taller, with respect to body weight only those in group 3 perceived themselves to be less. With respect to BMI, 95 students (88.8%) are of normal weight, only the groups between 31 and 40 years (G.3 and G.4), presenting overweight. There was underestimation with the self-report technique in all groups and with the figure perception technique there was underestimation in groups 1 and 4 (74. 7%), and overestimation in groups 2 and 3 (25.3%). Tests were carried out to verify if there were differences between the variables real BMI, self-reported and perceived by figures, performing analyzes in general, by gender and age of the participants. The T test was performed for paired samples, where the variables studied were compared. Table 3 shows the results of the group in general, in which it can be observed that there are differences between the real height and the self-reported (p=.000) and between the real BMI and the self-reported (p=.004) and between the real BMI with the one perceived by figure (p=.036). Highlighting these results is that students overestimate actual height and underestimate actual BMI.

To analyze the study variables according to the sex of the participants, the test for independent samples was used, which determined significant differences (p<.001) in all the variables, with men presenting greater height, weight and BMI both measured and perceived. In order to analyze the differences between the anthropometric variables of the students according to sex, we proceeded to divide the data from the SPSS matrix into two (men and women), establishing in each of them all the study variables. T-tests were carried out for related samples, which yielded the results shown in Table 4. In the case of women, significant differences were established in the variable real height versus self-reported height (p =.001) and between the real BMI versus the BMI perceived by figures (p =.000). In men, differences were also established in height (p=.000) and in actual BMI versus self-reported BMI (p=.001). Highlighting in both cases an overestimation of the height and underestimation of the real BMI. The men turned out to be more effective in the perception of the figure and the women in the self-report with respect to the real BMI.

When the ANOVA test was performed, to see if there were differences according to the age groups of the students. The results presented in Table 5 show us that there are differences in the study variables, only in height they were not significant. To establish between which age groups the differences were established, post hoc tests were performed using Bonferroni adjustment. In the real and self-reported body weight, a difference was established between G.1 and G.3, being in this case the heaviest ones in the last group (more than 12 kg) and between G.3 and G.4 only in weight. Self-reported perceiving the last group heavier, in both cases with significance (p<.05).

In real, self-perceived and figure-perceived BMI, differences were also established between G.1 and G.3 (p<.05), the latter group being categorized as overweight.

The Pearson Correlation test was performed to see the incidence of self-perception variables with the real ones, as well as the variables of sex and age. Table 6 shows that sex has a negative correlation with all the variables, since women and men presented significant differences in all of them. In the rest of the variables, there are positive and significant correlations between the real and self-perceived measurements in each of the variables; Strong correlations were obtained between real (r =.726) and perceived (r =.749) height with significance (p<.001) and between real BMI with self-reported BMI (r =.915) and with BMI perceived by figures (r =.629).

A complementary analysis was carried out to see if the perception variables could predict the real variables. For them, a linear regression analysis was performed to determine the predictive value of each of the self-reported variables with the real ones. Table 7 shows the Summary of the linear regression model, observing the values of R2 it is established that the self-reported height variable can predict 94.8% of the real height, the self-reported body weight 93.8% of the body weight real, self-reported and figure-perceived BMI could predict 83.7% and 37.9% respectively of real BMI.

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Table 1 Real, self-reported and perceived Body Mass Index according to sex

Sex	R Size (m)	SR Size (m)	R BW (kg)	SR BW (kg)	R BMI (Kg/m²)	SR BMI (Kg/m²)	SR BMI F (Kg/m²)
Men n=67	1,73±,061	1,74±,05	75,53±9,98	75,92±9,61	25,15±2,85	24,83±2,53	25,74±3,10
Women n=40	1,60±,046	1,61±,04	60,07±7,70	59,89±7,77	23,03±2,36	22,82±2,57	21,24±2,42
Total N=107	1,68±,081	1,70±,08	70,34±11,8	70,54±11,8	24,44±2,87	24,16±2,71	23,32±2,76

Note: R Size, Real size; SR Size, self-reported size; R BW, Real body weight; SR BW, Self-reported body weight; R BMI, Real Body Mass Index; SR BMI, Self-reported Body Mass Index; SR BMI F, Self-reported Body Mass Index figures.

Table 2 Real, self-reported and perceived Body Mass Index according to age

Age (years)	R Size (m)	SR Size (m)	R BW (kg)	SR BW (kg)	R BMI (Kg/m²)	SR BMI (Kg/m²)	SR BMI F (Kg/m²)
C.1 n=75	1,67±,081	1,69±,083	68,11±11,19	68,36±11,21	23,95±2,70	23,72±2,70	23,33±3,51
C.2 n=20	1,70±,08	1,71±,08	71,88±10,03	72,14±10,07	24,73±2,17	24,43±2,10	24,82±3,16
C.3 n=7	1,72±,05	1,74±,05	81,96±10,6	80,72±9,59	27,32±3,35	26,49±2,63	28,11±1,52
C.4 n=5	1,74±,07	1,77±,08	81,62±16,8	83,40±17,7	26,66±4,8	26,55±4,92	26,19±4,14

Note: C, cluster; Note: R Size, Real size; SR Size, self-reported size; R BW, Real body weight; SR BW, Self-reported body weight; R BMI, Real Body Mass Index; SR BMI, Self-reported Body Mass Index; SR BMI F, Self-reported Body Mass Index figures.

Table 3 Differences between self-reported and figure perception techniques in BMI

Variables	Paired differences ℘	SD	MSE	95% confidence interval of the difference		t	df	Sig. (bilateral)
				Lower Bound	Lower Upper			
R Size– SR Size	-,014	,02	,002	-,02	-,01	-7,95	106	,000**
R BW– SR BW	-,057	2,96	,287	-,62	,51	-,19	106	,843
R BMI– SR BMI	0,46	1,19	0,115	0,11	0,56	2,907	106	,004*
R BMI– SR BMI F	0,53	2,58	0,250	0,03	1,02	2,123	106	,036*
SR BMI– SR BMI F	0,20	2,58	0,250	-0,30	0,69	0,782	106	,436

Note: *p<.05; **p< .001; MSE, mean standard error; R BMI, Real Body Mass Index; SR BMI, Self-reported Body Mass Index; SR BMI F, Self-reported Body Mass Index figures.

Table 4 Differences between self-reported and figure perception techniques in BMI according to sex

Variables	Sex	Paired differences ℘	SD	MSE	95% confidence interval of the difference		t	df	Sig. (bilateral)
					Lower Bound	Lower Upper			
R Size– SR Size	W	-,01	,017	,003	-,015	-,005	-3,7	39	,001*
R BW– SR BW	W	,32	3,725	,58	-,87	1,51	,53	39	,590
R BMI– SR BMI	W	,21	1,50	,23	-,27	,69	,88	39	,383
R BMI– SR BMI F	W	2,68	2,02	,320	2,03	3,32	8,37	39	,000**
R Size– SR Size	M	-,02	,019	,002	-,022	-,01	-7,19	66	,000**
R BW– SR BW	M	-,28	2,40	,29	-,86	,30	-,96	66	,340
R BMI– SR BMI	M	,40	,96	,117	,17	,64	3,48	66	,001*
R BMI– SR BMI F	M	-,18	2,5	,31	-,80	,44	-,55	66	,56

Note: *p<.05; **p< .001; MSE, mean standard error; R BMI, Real Body Mass Index; SR BMI, Self-reported Body Mass Index; SR BMI F, Self-reported Body Mass Index figures.

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Table 5 Differences between self-reported and figure perception techniques in BMI according to age

Variable		Sum of squares	df	Mean squares	F	Sig.
R Size	Inter-group	,039	3	,013	2,066	,109
	Intra- group	,649	103	,006		
	Total	,688	106			
SR Size	Inter- group	,052	3	,017	2,668	,052
	Intra- group	,673	103	,007		
	Total	,726	106			
R BW	Inter- group	1,997,133	3	665,711	5,397	,002*
	Intra- group	12,703,975	103	123,340		
	Total	14,701,108	106			
SR BW	Inter- group	1,969,798	3	656,599	5,245	,002*
	Intra- group	12,895,187	103	125,196		
	Total	14,864,985	106			
R BMI	Inter- group	100,089	3	33,363	4,181	,008*
	Intra- group	821,917	103	7,980		
	Total	922,005	106			
SR BMI	Inter- group	77,379	3	25,793	3,620	,016*
	Intra- group	733,981	103	7,126		
	Total	811,360	106			
SR BMI F	Inter- group	182,909	3	60,970	5,451	,002*
	Intra- group	1,152,157	103	11,186		
	Total	1,335,065	106			

Note: *p<.05

Table 6 Correlations between anthropometric measurements and BMI, self-reported techniques, perception of figure and real

		Sex	Age	R Size	SR Size	R BW	SR BW	R BMI	SR BMI	SR BMI F
Sex	Pearson Correlation	1								
	Sig. (unilateral)									
Age	Pearson Correlation	-,267**	1							
	Sig. (unilateral)	,005								
R Size	Pearson Correlation	-,726**	,211*	1						
	Sig. (unilateral)	,000	,029							
SR Size	Pearson Correlation	-,749**	,241*	,974**	1					
	Sig. (unilateral)	,000	,012	,000						
R BW	Pearson Correlation	-,637**	,352**	,732**	,746**	1				
	Sig. (unilateral)	,000	,000	,000	,000					
SR BW	Pearson Correlation	-,658**	,361**	,753**	,764**	,969**	1			
	Sig. (unilateral)	,000	,000	,000	,000	,000				
R BMI	Pearson Correlation	-,369**	,319**	,285**	,309**	,849**	,798**	1		
	Sig. (unilateral)	,000	,001	,003	,001	,000	,000			
SR BMI	Pearson Correlation	-,358**	,326**	,307**	,299**	,804**	,841**	,915**	1	
	Sig. (unilateral)	,000	,001	,001	,002	,000	,000	,000		
SR BMI F	Pearson Correlation	-,524**	,308**	,466**	,466**	,683**	,686**	,616**	,629**	1
	Sig. (unilateral)	,000	,001	,000	,000	,000	,000	,000	,000	

Note: **The correlation is significant at the level 0.01 (unilateral)

*La correlación es significante al nivel 0.05 (bilateral)

Table 7 Linear regression model of anthropometric data and real, self-reported, perceived BMI by figure.

Predictor variable	Model	R	R Square	Ajusted R Square	Std. error of the estimate
SR Size	1	,974a	,948	,948	,01838
SR BW	1	,969a	,938	,937	294,534
SR BMI	1	,915a	,837	,836	119,571
SR BMI F	1	,616a	,379	,373	233,467

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Discussion

The objective of this study was to compare mean values of weight, height and BMI according to different measurement techniques and to analyze the differences between age and sex of students of the Physical Education major in Catamarca (Argentina). We begin by determining that the general sample has a BMI of 24.31 Kg/m^2, being the same categorized as normal weight according to the WHO, the men presented a BMI of 25.42 kg/m^2, being higher than students from Colombia,[17] Chile,[3,19] but similar in women of 23.19 kg/m^2 to other university populations,[3,17] but lower in both sexes than university students from Brazil and Panama.[18,19]

In the data obtained in our study, both from the sample in general and discriminated by sex, men were overweight and not women, similar to data obtained with university students from Brazil,[20,21] Spain.[22] It is known in the scientific community that the BMI does not differentiate between fat weight and muscle weight, the existence of overweight and obesity may or may not be related to an increase in body fat.[17] Therefore, the prevalence of overweight in men in this case, although it is minimal, it may be more related to muscle mass, taking into account that they are Physical Education students and therefore more prone to perform physical-sports activities than students of other university careers. Regarding the discrepancy established between the real and self-reported BMI, Maukonen et al.,[10] in a bibliographic review that included 62 publications on self-reported BMI in adult populations, reported a tendency to overestimate self-reported height and to underestimate or overestimate height. weight in comparison with the measured values and an underestimation of the BMI for both sexes; coincide with the results obtained in this study and others carried out in different populations,[9,12,13] and with university students,[19,23,24]. This discrepancy between what was measured and what was self-reported is due to the fact that the BMI formula is more sensitive to inaccuracies of height than weight.[24]

When we analyze the real BMI with the one perceived with figures, we also found an underestimation of the BMI of the sample in general, the discrepancy being only significant in women, results different from those reported by Soto et al.,[1] in which the women overestimated the true BMI. Regarding the self-reported and perceived BMI by figure according to the ages of the participants, the antecedents indicate the existence of a relationship between age and overestimation (the younger the age, the greater the overestimation).[24] In this study, differences were observed according to age group, but not following this statement, rather the perception was more related to the real BMI, which was higher according to age.

Despite discrepancies between self-reported and anthropometrically obtained data, the results of the correlations detected that self-reported height, weight, and BMI were strongly correlated with their measured counterparts in this sample (all p values < 0.001), similar results obtained by other authors in different populations,[5,9,12] and in university students.[23,24] Finally, we were able to determine in this sample of Physical Education students that the BMI established by the two perception techniques used underestimate the BMI measured by anthropometry, coinciding with those of Rodríguez et al.,[9] who considered the technique of self-report than figure to determine actual BMI. Therefore, it is suggested to use the self-report technique in similar populations in Argentina when anthropometric measurements of weight and height cannot be performed to determine the BMI. In the interpretation of the results, some weaknesses of the study must be considered, firstly, it is not a representative sample of the university community of the National University of Catamarca and secondly, the differences between the ages of the participants, in a very wide range uneven, and in the distribution of the sample according to sex, since there were many more men than women.

Conclusion

The BMI established by the self-report and figure perception techniques underestimate the BMI measured by anthropometry, the self-report technique being the most effective of these, obtaining a high coincidence with the real BMI and with a high predictive value of its estimation.

Acknowledgments

None.

Conflicts of interest

The authors declare no conflicts of interest regarding the research and findings presented.

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