Body Mass Index in a Military Population and its Correlation with Other Anthropometric Indicators

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Abstract

The Body Mass Index (BMI) has been used to evaluate overweight and obesity in the military population. However, its use as the sole anthropometric indicator is probably inadequate considering this population's specific characteristics. Therefore, there may be both false positive and false negative cases of overweight and obesity. ***Objective.*** This study sought to establish the relevance of the body mass index as an estimator of adiposity (overweight and obesity) in the military population and its relationship with other anthropometric indicators. ***Materials and methods.*** A retrospective transversal study was carried out with 137 military trainees in different Colombian Army schools. Sociodemographic information, such as age, sex, and the army school to which they belonged, was collected. The anthropometric evaluation included height, weight, and waist circumference measurements. Body composition was also evaluated by using electrical bioimpedance (Seca BmCA 550). A description of the prevalence of overweight and obesity, correlation coefficients, and diagnostic concordance was established by using Cohen's Kappa index. Likewise, BMI sensitivity and specificity were described against indicators, like body fat percentage and fat mass index, considered body composition Gold Standards. ***Results.*** The correlation between body weight was higher with fat-free mass weight (FFM) than with the fat mass weight (r = 0.851, p = 0.000, r =

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0.642, p = 0.000), respectively. The correlation between BMI was good and positive with body fat percentage (BFP) (r = 0.750, p = 0.000) and higher with fat mass index (FMI) (0.836, p = 0.000). The waist-to-height ratio (WHtR) showed the best correlation with BFP and FMI. The BMI concordance with BFP (r = 0.750, p = 0.000) and FMI (0.836, p = 0.000) was positive. ***Conclusions.*** While the BMI presented good concordance with the BFP and the FMI, it also overestimated the prevalence of overweight. It underestimated the prevalence of obesity in a smaller proportion, with high sensitivity but low specificity for the diagnosis of overweight and high specificity and sensitivity for obesity. Although the BMI shows a positive correlation with adiposity indicators, it cannot be considered the indicator to diagnose overweight and obesity in the military population. It presents false positives for overweight and false negatives for obesity. In this line, weight in the military population is significantly correlated with muscle and fat-free mass rather than fat, given that this is a physically active population that undergoes specific training favoring muscle mass development. The FMI is the indicator that best predicts body fat, along with the WHtR. Use of the Lean Mass Index (LMI) should be considered a parameter to measure this body component.

Keywords: BMI, body fat percentage, fat mass index, adiposity indicators, electrical bioimpedance, anthropometry, body composition

Introduction

During training, military personnel are subjected to multiple activities and physical efforts related to daily performance, as well as part of the training routines and combat courses. These activities require maintaining good physical condition and adequate body composition, aspects that, according to Castañeda and Caiffa (2015), are closely related with better physical performance (1). In its first program to promote exercise and healthy eating habits in 1981, the U.S. Department of Defense's approach emphasized that maintaining adequate body composition is an integral part of physical condition and plays a vital role in a professional military appearance. Furthermore, it is a good indicator of the military personnel's general health and well-being (2)many Sailors believe the current method fails to accurately predict body fat percentage. As a result, the Naval Health Research Center (NHRC).

Evaluation of physical conditions in the Colombian military context uses the BMI as a reference to classify overweight and obesity (3). Using the BMI as the sole indicator of these conditions is probably inappropriate. Considering the high development of lean mass (LM) resulting from physical training, a high BMI could be reported (overweight or obesity), which, in reality, is a high LM; this is considered a false positive. In other cases, the BMI could report normality and, in reality, the person has a high-fat mass (FM) in their body composition, again, a false negative. Therefore, defining body composition to assess variables that enable BMI identification by high LM or high FM, using easily accessed and used validated methods, like electrical bioimpedance and anthropometry, is essential.

This study's purpose was to establish the relevance of using BMI as the sole indicator of nutritional status in a military population in training. It sought to evaluate using other indicators to differentiate between military personnel with high LM and high FM by correlating BMI with variables, like percentage of fat, FMI, LMI, waist circumference, and waist-to-height ratio.

Body mass index as an indicator of overweight and obesity in the military

The body mass index was proposed in 1832 by Adolphe Quetelet (4) as a global indicator of nutritional status. It establishes a relationship between weight (kg) and the squared height (m) (BMI = weight kg/height m). The BMI is an inexpensive, simple, and fast tool widely used to determine overweight and obesity. The World Health Organization (WHO) establishes the following cut-off points: normal, 18.5 kg/m^2 to 24.9 kg/m^2, overweight 25 kg/m^2 to 29.9 kg/m^2, and obesity >30 kg/m^2 (4). According to this same organization, overweight and obesity are defined as an excessive or abnormal fat accumulation that can be harmful to health. By 2016, 39% of people over 18 worldwide will be overweight and 13% obese (4). In Colombia, according to the figures reported by the 2015 National Food and Nutrition Survey (ENSIN in Spanish), 56.4% of the adult population (18 - 64 years of age) was overweight (37.7% overweight and 18.7% obese), with 59.6% more women than men 52.7% (5). This outlook is not foreign to the military personnel worldwide and in Latin America (6–8)se ha cuestionado su exactitud y apli-cación en diversas poblaciones. Bioimpedance is a method that offers the possibility of knowing the percentage of total body fat, considered a parameter to diagnose obesity. Objective: to analyze the correlation between BMI and total body fat percentage to establish the diagnosis of overweight and obesity. Methodology: an observational, analytical-comparative, prospective, and cross-sectional study carried out in the outpatient clinic of the Hemodialysis Service of the Hospital Central Militar, in May 2015. Healthy volunteers were evaluated. The volunteers were over 18 years of age, of either gender, and consenting to the anthropometric measurements. Bioimpedance equipment was used (InBody770 ®.

For example, in the Colombian context, according to the BMI, a study carried out with pilots identified that 68.9% and 8.7% were overweight and obese, respectively (9). Another study at *Escuela Militar de Cadetes "General José María Córdova"* evaluated the nutritional status of 72 cadets before an advanced combat course and found that 23% and 4.1% of the population had a BMI showing overweight and obesity, respectively (10).

The BMI is the most widely used diagnostic tool to define overweight and obesity, indicating excess fat mass. However, this measurement does not establish a difference between fat and lean mass, which varies widely according to gender, age, race, and level of physical activity, among other aspects (11, 12).

Different studies have concluded that BMI alone is inadequate to assess body composition because it reports false negative or false positive results when assessing body fat (13,14). A study by Carrasco (2004) observed that BMI overestimated overweight in 19% of men evaluated and underestimated obesity in 23%, compared to BFP (15).

Given this evidence, the question arises regarding the relevance of the BMI measurement as the sole estimator of overweight and obesity in the military population, considering that it is a physically active population. A study carried out in the military environment in the Chilean population reported that the BMI overestimated overweight by 23% compared to the percentage of fat, but adequately estimated obesity (16). Similarly, a study conducted in the Mexican military found that some of the individuals classified as overweight according to BMI were normal according to FMI (17). According to Tyson *et al.*, (2015) in an American military population, a BMI between 25 and 27 had a strong correlation, mainly with increased fat-free mass (18)with a BMI of 26.4, and approximately 18% BF. The correlation between BMI and %BF (R = 0.86(19).

Other anthropometric indicators

Abdominal Circumference (AC): along with the BMI, AC is one of the most commonly used indicators to assess body fat. It is an indicator of regional fat distribution and considered the anthropometric measure *par excellence* to diagnose abdominal obesity, cardiovascular risk, and metabolic syndrome (20, 21) because of its association with visceral or ectopic fat deposits. According to a study conducted in a Chilean university population, it seems to be a better predictor of adiposity than BMI in a young population (22). It is also noteworthy that within the U.S. Navy's body composition standards, which has established its own formula to determine BFI%, the AC is considered one of the variables to determine overweight and obesity (23, 24).

The AC has different cut-off points to classify abdominal obesity. According to the WHO, a circumference > 94 cm in men and 80 cm in women is classified as pre-obesity or increased cardiovascular risk. An AC > 102 cm and 88 cm in men and women, respectively, represents abdominal obesity and a very high risk of comorbidity (20). In turn, the 2013 consensus, "Harmonizing the Metabolic Syndrome," adopted values of 90 cm for men and 80 cm for women (25)which occur together more often than by chance alone, have become known as the metabolic syndrome. The risk factors include raised blood pressure, dyslipidemia (raised triglycerides and lowered high-density lipoprotein cholesterol.

Waist-to-Height Ratio (WHtR): is the AC value corrected for height. Its predictive power is given because of its association with cardiometabolic risk (26), with values above 0.51. Thus, and according to results published in the American Journal Clinical Nutrition by Flegan (2009), it was observed that WHtR is a better predictor of adiposity than BMI and AC alone (27).

Body fat percentage (BFP): based on body fat deposits, the Spanish Society of Endocrinology and Nutrition (SEEDO in Spanish) defines a BFP between 12% and 20% and 20% to 30% for men and women, respectively, as normal. It considers a 21% to 25% in men, and 30% to 33% in women limit or overweight, and > 25% in men and >33% in women as obesity (28).

Fat Mass Index (FMI): is the absolute fat corrected for height (fat kg/height m^2) for which there is no consensus on cut-off points. According to Peine *et al.*, (2013) values below 5.60 kg/m^2 and 7.90 kg/m^2 are considered normal. Overweight is between > 5.61 kg/m^2 at 7.08 and >7.91 at 10.30, and obesity is >7.090 kg/m^2 and 10.31 kg/m in men and women, respectively (29). In another study, FMI > 5.4 kg/m^2 and 7.80 kg/m^2 in men and women, respectively, was correlated with overweight and obesity (30).

The LMI or FFMI fat-free mass index: is the fat-free mass corrected for height (LMI or FFMI = FFM (kg)/height^2 (m). It is used to classify individuals with similar body composition but differences in height. The BMI erroneously classifies individuals as overweight at the expense of muscle mass; this may be the case for a percentage of the military population. The FFMI is particularly useful for short individuals with good muscle development, classified as overweight and obese by BMI (31).

Methods

A retrospective, cross-sectional observational study was conducted. The data included in this study was obtained from active students from different military training schools, including *Escuela Militar de Suboficiales* (EMSUB), *Escuela Militar de Cadetes "General José María Córdova"* (ESMIC), and *Escuela de Soldados Profesionales* (ESPRO). The data were taken at each of the schools located in Bogotá and Cundinamarca (Melgar) during August 2018. All male students in each of the schools' last level, available on the day of the data collection, were summoned. The total sample consisted of 137 males between the ages of 19 and 31 years; females were excluded. Individuals with incomplete measurement variables or those failing to comply with the electrical bioimpedance test preparation recommendations (fasting, not having done physical activity in the previous 12 hours, maintaining an adequate state of hydration) were also excluded, as well as those not having signed the informed consent and amputees.

Written informed consent was obtained from each participant. The institution's research, technology, and development area's ethics committee approved the intervention following the Declaration of Helsinki's rules and the legal regulations in force in Colombia that regulate human research (Resolution 008439 of 1993 by the Colombian Ministry of Health).

Measurement variables

Height, weight, and waist circumference were measured and collected by a Level 1 ISAK (International Society for Advancement in Kinanthropometry) certified anthropometrist. The measurement instruments used were a portable stadiometer (Seca 206®, Hamburg, Germany) with a 0 - 220 cm range and 1 mm accuracy for height. For weight, a Seca 813 electronic floor scale (200 kg) with 100-gr accuracy was used. Waist circumference was measured by using a Lufkin W606PM inextensible steel flexible measuring tape. Waist circumference was taken at the midpoint between the lower edge of the last rib and the iliac crest's upper edge.

Body composition was evaluated by using tetrapolar electrical bioimpedance with a Seca mBCA 525 medical Body Composition Analyzer to establish variables, like fat percentage, fat mass index, muscle mass index, and fat-free mass, following the manufacturer's recommendations (no food or drink 4 h prior to the test, no exercise 12 h prior, urination 30 min prior, and no alcohol consumed 24 h prior). Assessments were performed on a stretcher in supine position with arms and legs slightly off the midline.

The waist-to-height ratio was determined by dividing the waist (cm) by the height (cm) measurement using a value of ≥ 0.51 as a reference for the discrimination of abdominal obesity and cardiovascular risk (32). The SEEDO 2000 and 2007 criteria previously described were taken into account to determine the body adiposity level. The following cut-off points were considered for the FMI: normal, <5.60 kg/m^2; overweight, <7.08 kg/m^2; and obesity, >7.09 kg/m^2 (29). Between p25 and p75 (18 to 19.8 kg/m^2) was considered normal for the FFMI, and >p90 >19.9 kg/m^2 was considered high (33).

Table 1. Variables and cut-off points

Variable	Reference	Cut-off point	Interpretation
Body Mass Index (BMI)	WHO	18.5 kg/m^2 to 24.9 kg/m^2	Normal
		25 kg/m^2 to 29.9 kg/m^2	Overweight
		> 30 kg/m^2	Obese
Waist (cm) to Height (cm) Ratio(WHtR)		≥ 0.51	Abdominal obesity and moderate cardiovascular risk
Abdominal Circumference (AC)	Harmonizing the Metabolic Syndrome 2013	> 90 cm	Pre-obesity and cardiometabolic risk
Fat Mass Index (FMI)	Paine *et al.* 2013	< 5.60 kg/m^2	Normal
		> 5.61 and < 7.08 kg/m^2	Overweight
		> 7.09 kg/m^2	Obese
Fat-Free Mass Index (FFMI)	Schutz *et al.*, 2002	P25 and p75(18 to 19.8 kg/m^2)	Normal
		> p90 >19.5 kg/m^2	High
Body Fat Percentage (BFP)	SEEDO 2000 and 2007	12% - 20%,	Normal
		20% - 25%	Overweight
		> 25%	Obese

Source: Material created by the author.

A descriptive analysis was performed to analyze the information to establish the mean and standard deviations and minimum and maximum values.

The SPPSS 25 statistical package was used, applying Kolmogorov-Smirnov normality tests to establish the data's normality to this end. Spearman's Correlation test was used for non-parametric data and diagnostic agreement was established between the BMI and BFP and the BMI and FMI by using Cohen's Kappa Index. The BMI's sensitivity and specificity were calculated against the BFP and FMI, taken as the standard Gold reference.

This research's potential biases are associated mainly with compliance with the electrical bioimpedance evaluation protocol, such as the challenge to guarantee that participants had fully adhered to the recommendations.

Results

The results from 137 males in the Colombian Army's training schools were analyzed. The distribution by school was ESMIC 32.8% (n = 45), ENSUB 34.3% (n = 47), and ESPRO 32.8% (n = 45). The average age of the population was 22 +/-1.8 years. The average weight was 66.5 kg +/-8.04 kg, with minimum values of 46.7 kg and maximum of 90.5 kg. The average BMI was 23.3 +/-2.22 kg/m^2. The summary of the other descriptive data for the anthropometric variables analyzed is shown in Table 2.

Table 2. Description of anthropometric variables in personnel undergoing training in three schools of the Colombian Armed Forces.

	N	MEDIAN	SD	MINIMUM	MAXIMUM	PERCENTILES		
						25	50	75
WEIGHT	137	66.5	8.04	46.7	90.5	60.75	65.8	71.5
HEIGHT		1.69	0.07	1.54	1.84	1.64	1.68	1.74
BMI[1]		23.3	2.22	18.8	29.4	21.8	23.1	24.6
BFP[2]		16.4	5.63	5.9	34.7	12.4	15.7	20.5
FMI[3]		3.9	1.68	1.20	9.8	2.76	3.44	4.9
LMI[4]		19.4	1.13	16.6	22.1	18.6	19.4	20.2
WAIST		78.8	5.72	67.0	96.0	75.0	78.0	82
WHtR[5]		0.47	0.04	0.40	0.60	0.44	0.46	0.49

[1]Body Mass Index, [2]Body Fat Percentage, [3]Fat Mass Index, [4]Fat-free mass index, [5]Waist-to-Height Ratio.

Source: Material created by the author.

According to the BMI, 79.5% (n = 109) of the subjects were normal, 20.4% (n = 28) were overweight (n = 14), and no cases of obesity were reported. According to the BFP, 13.1% (n = 18) of the subjects were classified as overweight and 8% (n = 11) as obese. The FMI reported 11.7% (n = 16) overweight and 4.4% (n = 6) obese (Figure 1).

Of the population with normal BMI, seven individuals had overweight values with BFP and two with FMI (false negatives). Of the 28 individuals classified overweight by BMI, seven had a normal BFP and eight had a normal FMI (false positives). In the obesity classification, the BMI did not report any case. Meanwhile, 11 were presented by BFP and six by FMI (false negatives for obesity) (Tables 3 and 4).

According to the LMI or FFMI, 87% of the population had a normal or high reserve of MM. Therefore, 53% (n = 73) of the individuals were within the 25th to 75th percentiles and 34% (n = 47) were over the 75th percentile. Of all the individuals with BMI in overweight ranges, 71% (n = 20) also had an FFMI above the 75th percentile.

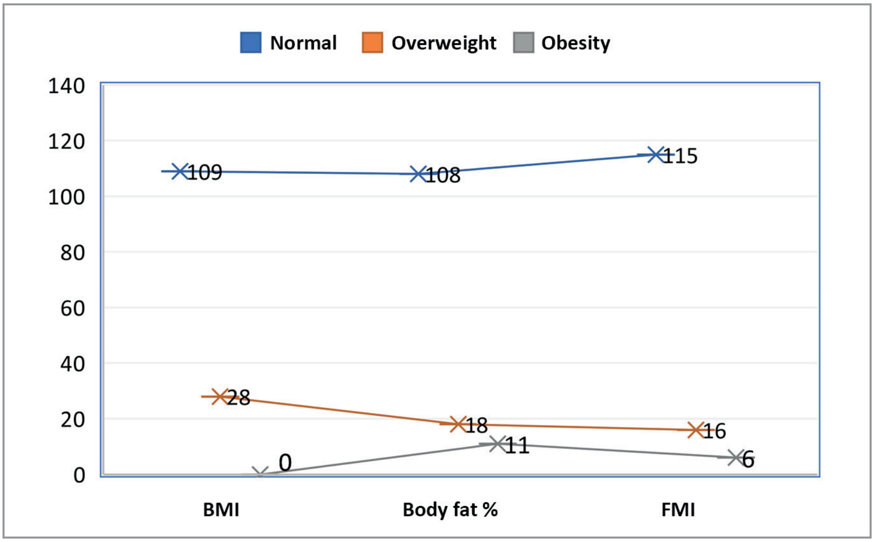

Figure 1. Prevalence of overweight and obesity according to Body Mass Index (BMI) kg/m^2, body fat percentage (BFP), and Fat Mass Index (FMI) kg/m^2

Source: Material created by the author

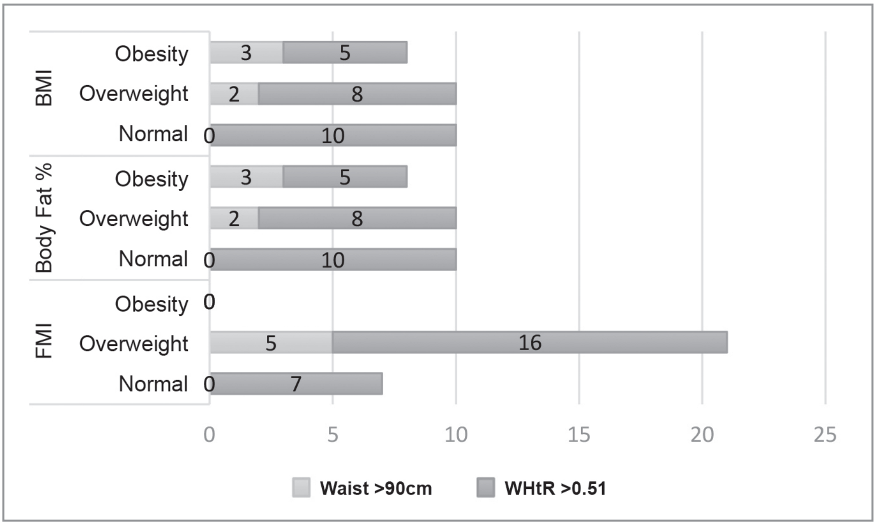

Figure 2. Abdominal adiposity measured by waist circumference and corrected by height to calculate the waist-to-height ratio, compared to adiposity indicators, like BMI, BFP, and FMI.

Source: Material created by the author.

Regarding regional fat distribution, 3.6% (n = 5) of the individuals had an AC > 90 cm or high risk, according to WHO criteria. For their part, 16.7% (n = 23) had moderate cardiometabolic risk according to WHtR (WHtR > 0.51) (Figure 2).

In this population, the most significant positive correlation was among weight and muscle mass (MM) and FFM (r = 0.851, p = 0.00 and r = 0.82 p = 0.00, respectively) followed by the BMI and the FMI (r = 0.836, p = 0.00) and the FMI with the WHtR (r = 0.725 p = 0.000) (Figures 3 and 4). A high positive correlation was also observed among height and MM and the FFM (r = 0.710 p = 0.000 and r = 0.805 p = 0.000, respectively). The WHtR showed better correlation with the BFP (r = 0.691, p = 0.000) and the FMI (r = 0.725, p = 0.000) than the AC (r = 0.650, p = 0.000 and r = 0.698, p = 0.000) (Table 1).

Table 3. Spearman's Rho Correlation Coefficients between the quantitative variables in the Colombian Military Forces' 2018 Formation

		EDAD (años)	PESO (kg)	TALLA (mt)	IMC (kg/mt2)	GRASA (%)	GRASA (kg)	MM (kg)	IMG (kg/mt2)	FFMI (kg/mt2)	CINTURA (cm)	ICA	MLG (kg)
EDAD	Coeficiente de correlación	1,000	0,156	-0,002	,183*	,201*	,206*	0,110	,209*	0,129	,187*	,186*	0,064
	Sig. (bilateral)		0,069	0,982	0,032	0,018	0,016	0,199	0,014	0,134	0,029	0,029	0,457
PESO	Coeficiente de correlación		1,000	,599**	,718**	,441**	,642**	,851**	,517**	,627**	,669**	,275**	,819**
	Sig. (bilateral)			0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000
TALLA	Coeficiente de correlación			1,000	-0,074	-,174*	0,016	,710**	-0,162	0,104	0,115	-,414**	,805**
	Sig. (bilateral)				0,393	0,042	0,851	0,000	0,059	0,228	0,182	0,000	0,000
IMC	Coeficiente de correlación				1,000	,750**	,833**	,455**	,836**	,680**	,758**	,713**	,338**
	Sig. (bilateral)					0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
GRASA	Coeficiente de correlación					1,000	,966**	0,005	,988**	0,077	,650**	,691**	-0,097
	Sig. (bilateral)						0,000	0,952	0,000	0,368	0,000	0,000	0,261
GRASAkg	Coeficiente de correlación						1,000	,232**	,979**	,232**	,733**	,656**	0,137
	Sig. (bilateral)							0,006	0,000	0,006	0,000	0,000	0,111
MMkg	Coeficiente de correlación							1,000	0,100	,710**	,434**	0,017	,960**
	Sig. (bilateral)								0,244	0,000	0,000	0,841	0,000
IMG	Coeficiente de correlación								1,000	,211*	,698**	,725**	-0,009
	Sig. (bilateral)									0,013	0,000	0,000	0,920
FFMI	Coeficiente de correlación									1,000	,457**	,334**	,651**
	Sig. (bilateral)										0,000	0,000	0,000
CINTURA	Coeficiente de correlación										1,000	,829**	,340**
	Sig. (bilateral)											0,000	0,000
ICA	Coeficiente de correlación											1,000	-0,119
	Sig. (bilateral)												0,168
MLGkg	Coeficiente de correlación												1,000
	Sig. (bilateral)												

Source: Material created by the author

* The correlation is significant at the 0.05 level (bilateral). ** The correlation is significant at the 0.01 level (bilateral).

In assessing the BMI's sensitivity and specificity as a diagnostic test for overweight and obesity compared to BFP and FMI as Gold standard diagnostic tests, a sensitivity of 0.94 and specificity of 0.61 for BFP were observed in diagnosing overweight. For obesity, the sensitivity and specificity were 0.94 and 0.91, respectively. The FMI (height-corrected fat mass as another Gold standard test for adiposity assessment) showed a sensitivity of 0.90 and specificity of 0.87 for overweight and sensitivity and specificity of 0.91 and 1.00 for obesity.

Cohen's Kappa coefficient to calculate diagnostic agreement between BMI and BFP and BMI and FMI as predictors of overweight and obesity, BMI vs. BFP was k = 0.41, and BMI vs. FMI was k = 0.598. Tables 2 and 3 show the presence of false positives and negatives for overweight and false negatives for obesity when compared to BMI.

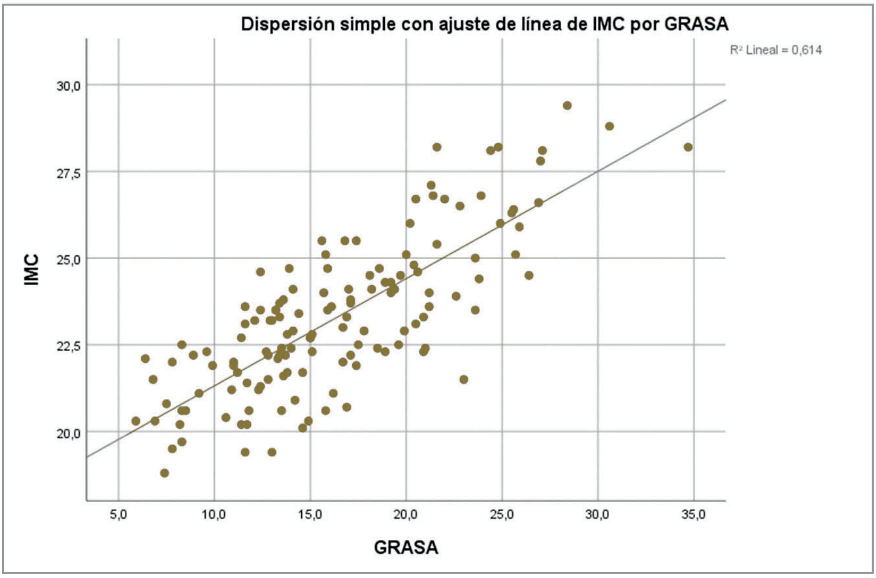

Figure 3. Correlation coefficient between BMI and fat % (CC 0.75, P = 0.00, 95%CI 15.5 - 17.3 kg/m^2).
Source: Material created by the author

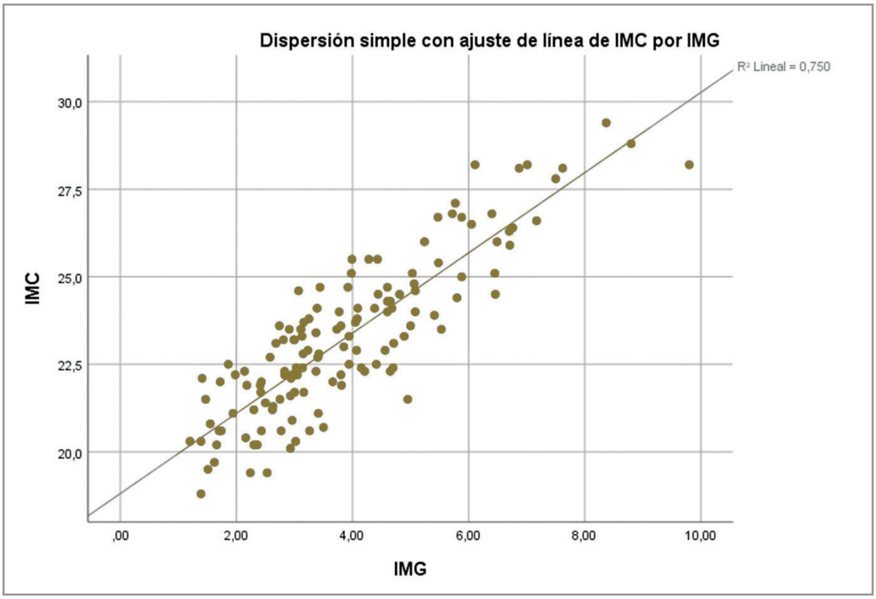

Figure 4. Correlation coefficient between BMI and FMI (CC 0.84, P = 0.00, 95%CI 3.62 - 4.18 kg/m^2).
Source: Material created by the author

Table 3. BMI*BODY FAT (%) cross table

			% BODY FAT			
			Normal	**Overweight**	**Obesity**	**Total**
BMI	Normal	Recount	101	7	1	109
		% of total	73.7%	5.1%	0.7%	79.6%
	Overweight	Recount	7	11	10	28
		% of total	5.1%	8.0%	7.3%	20.4%
Total		Recount	108	18	11	137
		% of total	78.8%	13.1%	8.0%	100.0%

Source: Material created by the author

Table 4. BMI*FAT MASS INDEX (kg/m^2) cross table

			FAT MASS INDEX			
			Normal	**Overweight**	**Obesity**	**Total**
BMI	Normal	Recount	107	2	0	109
		% of total	78.1%	1.5%	0.0%	79.6%
	Overweight	Recount	8	14	6	28
		% of total	5.8%	10.2%	4.4%	20.4%
Total		Recount	115	16	6	137
		% of total	83.9%	11.7%	4.4%	100.0%

Source: Material created by the author

Discussion

The Ministry of National Defense's Permanent Directive of August 2018, "*Physical evidence evaluation parameters for military force officers and non-commissioned officers,*" (3) included as Annex F, lists the normal weight-to-height ranges, according to the BMI by adopting the WHO's cut-off points to diagnose overweight and obesity. However, despite being a user-friendly tool, the BMI incurs into errors in predicting overweight and obesity in the military population (16,17,34), using the BMI and body fat percentage by age group and comparing it with different anthropometric indicators. Material and methods: a cross-sectional study involving 415 soldiers. Sociodemographic information was obtained and an anthropometric evaluation was performed, including height, weight, and body composition measurements. A description of the prevalence of obesity was made, anthropometric measurements were compared according to age using an ANOVA test. Pearson correlations between anthropometric variables were performed and diagnostic agreement between BMI and body fat percentage was determined using the kappa index. Results: The prevalence of obesity in Buin soldiers was 14.3% and 14.0%, using BMI and body fat percentage, respectively. This prevalence increased progressively as the age of the soldiers increased ($p<0,05$. Although the BMI showed a significant correlation with both the BFP and FMI in this research, it was also observed that in the population studied, the BMI underestimated the prevalence of overweight compared to the BFP and the WHtR by 5.1% and 1.5%, respectively, and obesity by 8% and 4.4%, respectively. In turn, it overestimated overweight by 5.1% and 5.8% compared to BFP and WHtR, respectively. It should be noted that the individuals classified as overweight, according to BMI, and normal, according to BFP and WHtR, were in a BMI range between 25 and 27. This situation was observed in other studies in the military population, suggesting that in individuals with BMI between 25 and 27 in this population body composition should be considered to discriminate whether the overweight condition is at the expense of fat or lean mass (19).

The BMI's behavior in predicting overweight and obesity compared to other adiposity indicators is confirmed by the results reported by Vazquez-Guzman *et al.*, (2015) in a Mexican military population and Duran-Agüero *et al.*, (2015) in a Chilean military population. Therefore, by using the BMI as an indicator in the military population, the cut-off points must be adjusted, and considering that the FMI had the highest sensitivity and specificity and the highest Kappa value, the FMI can be established as the best indicator of adiposity for the military population. Peine (2013) compared the generation of normality ranges for body composition evaluated via electrical bioimpedance to the four-component fractionation method and DEXA, where the BFP overestimated overweight and obesity compared to FMI. This situation is similar to that observed in our research. In turn, the importance of using the WHtR as an indicator of regional adiposity is highlighted by its strong correlation with the FMI.

Moreover, and considering the other important component of body composition, fat-free mass, one of the most important findings was the high positive correlation among weight and muscle mass and fat-free mass, which was higher than the correlation between weight and absolute fat. This suggests important muscle development in this population that contributes to a higher BMI in the presence of normal fat levels. The aforementioned was also identified in Bustamante's (2015) research, which mentions higher-than-average muscle development in Argentinean cadets. This situation is not unrelated to our study in which LMI levels were higher than the 75^{th} percentile identified, according to the table published by Schutz (2002).

Considering Cohen's Kappa Index, which showed moderate diagnostic concordance between BMI and BFP and BMI and FMI, similar to that reported by Durán-Agüero (2017) in a Chilean military population, it can be stated that BMI alone is not an adequate diagnostic tool for the nutritional classification in the military population. It becomes essential to include other adiposity indicators to evaluate military trainees in the Colombian Army.

Within the limitations observed during this research, difficulty is highlighted in controlling compliance with the requirements to carry out bioimpedance, mainly the state of hydration of the population.

Conclusions

The BMI overestimates overweight (false-positive cases) and underestimates obesity in the military population (false-negative cases).

The BMI is not an objective indicator of the military personnel's nutritional status. Therefore, its use is only recommended as a screening tool and should be accompanied by other indicators, like the FMI and WHtR.

In future studies, larger samples are necessary to establish cut-off points for BMI, according to this population's body composition, considering that all schools do not have equipment to assess body composition or personnel trained in anthropometric techniques.

The FMI is a better indicator of adiposity in the military population, even better than the BFP. Taking height into account has less possibility of over or underestimation.

Using the WHtR is also recommended to predict obesity

These results cannot be extrapolated to the military population in exercise.

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