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Original Article

Diminished physical capacity in obese individuals with normal left ventricular function

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ARTICLE INFORMATION

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Acronyms
BMI: body mass index
DBP: diastolic blood pressure
DM: diabetes mellitus
FS: fractional shortening
HT: hypertension
IVS: interventricular septum
LV: left ventricle
LVM: LV mass
LVMI: LV mass index
LVDD: diastolic diameter
SBP: systolic blood pressure

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ABSTRACT
Introduction: Obesity is a pandemic today. The physical capacity of subjects with excess body weight decreases due to high energy consumption, even though their heart function is normal.
Objective: The objective was to determine the physical capacity in subjects with overnutrition and in those with normal weight, with normal systolic left ventricular function.
Method: A descriptive, observational, cross-sectional analytical study was conducted in 170 subjects who came to the General Calixto García University Hospital in Havana, Cuba from April 2009 to November 2012. The sample was divided, according to body mass index, into normal weight (50), overweight (60) and obese (60). An exercise test and an echocardiogram were performed.
Results: Females and white skin color predominated (53.2%, respectively). A sedentary lifestyle and adding salt to food were found in a greater proportion among the overweight and obese subjects (p<0.001 vs. normal weight). The systolic blood pressure at maximal effort differed between the groups: 200 ± 15 mmHg in obese subjects, 185 ± 27 mmHg in overweight subjects and 173 ± 24 mmHg in normal weight (p<0.05). The physical capacity, measured in METs, was low in obese subjects (5.8 ± 1.3) compared with overweight subjects (7.8 ± 2.1) and normal weight subjects (8.3 ± 1.7), p<0.001. The diameters, wall thickness and left ventricular mass increased in obese subjects with normal systolic function.
Conclusions: Physical capacity deteriorates as body mass index increases even with normal systolic left ventricular function.
Key words: Obesity, Physical capacity, Systolic function, Echocardiography, Exercise testing

Capacidad física disminuida en obesos con función normal del ventrículo izquierdo

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RESUMEN

Introducción: La obesidad es una pandemia en la actualidad. En sujetos con exceso de peso corporal la capacidad física disminuye debido al elevado consumo energético, aunque la función del corazón sea normal.

Objetivo: El objetivo fue determinar la capacidad física en sujetos con malnutrición por exceso y normopesos con función sistólica del ventrículo izquierdo normal.

Método: Estudio descriptivo, observacional, transversal y analítico, en 170 sujetos que acudieron al Hospital Universitario "General Calixto García" de La Habana, Cuba; de abril de 2009 a noviembre de 2012. La muestra se dividió según el índice de masa corporal en normopeso (50), sobrepeso (60), y obeso (60). Se realizó prueba ergométrica y ecocardiograma.

Resultados: Predominó el sexo femenino y el color de la piel blanca, (53,2 %, respectivamente). El sedentarismo y añadir sal a los alimentos se hallaron en mayor proporción en sujetos sobrepeso y obesos ($p<0.001$ *vs.* normopeso). La presión arterial sistólica al máximo esfuerzo difirió entre los grupos: obesos 200 ± 15, sobrepeso 185 ± 27 y normopeso 173 ± 24 mmHg ($p<0.05$). La capacidad física, medida en METS, fue baja en los obesos (5,8 ± 1,3), comparada con los sobrepeso (7,8 ± 2,1) y los normopeso (8,3 ± 1,7), $p<0.001$. Los diámetros, grosor de las paredes y masa del ventrículo izquierdo se incrementaron en obesos con la función sistólica normal.

Conclusiones: La capacidad física se deteriora a medida que se incrementa el índice de masa corporal aún con la función sistólica del ventrículo izquierdo normal.

Palabras clave: Obesidad, Capacidad física, Función sistólica, Ecocardiograma, Ergometría

INTRODUCTION

Two years ago, the deaths from heart disease were the first cause of death in Cuba, hence the increased mortality from 12.704 in 1970 to 22.234, in 2012, when it was second only to malignant tumors with 298 deaths more[1].

Risk factors for atherosclerosis, such as hypertension (HT), diabetes mellitus (DM), smoking, dyslipidemia, sedentary lifestyle and obesity, among others, are involved in the genesis and progression of cardiovascular disease.

The World Health Organization identifies obesity as a modifiable risk factor, with a rapid increase in its prevalence[2].

In Cuba, the second national survey of risk factors for atherosclerosis demonstrated that 7.92% of men and 15.44% of women have a body mass index (BMI) greater than 30 kg/m^2, while 29.7 and 31.5% were between 25 and 29.9 kg/m^2, respectively[3].

In morbidly obese subjects, physical capacity decreases during exercise due to high energy consumption, even when there is no symptom of cardiovascular decompensation. In addition, fat mass interferes with cardiac and lung function, and limits the aerobic response to exercise. Low physical capacity is identified as an independent predictor of death[4,5].

In recent years, the increase in subjects with overnutrition is being regarded as a health problem. From a practical standpoint, these subjects have no signs or symptoms of cardiovascular disease in the early years of their excess body weight, so they continue their wrong lifestyle. However, with the passing of time, obesity, as a risk factor, alters the structure and function of the cardiovascular system.

The objective of this study was to determine the physical capacity in subjects with overnutrition and in those with normal weight, with normal systolic left ventricular function.

METHOD

A descriptive, observational, cross-sectional analytical study was conducted in subjects who presented consecutively to the consultation of Cardiology at the General Calixto García University Hospital in Havana, Cuba, from April 2009 to November 2012.

The universe consisted of 540 individuals, of which a sample of 170 was selected taking into account the following inclusion criteria:

- Age between 18 and 70 years
- Any gender or skin color

- No personal medical history of ischemic heart disease (IHD)
- Presence or absence of other cardiovascular risk factors such as HT, smoking, DM, sedentary lifestyle, dyslipidemia, adding salt to food
- Signing the informed consent document.

The subjects who had absolute or relative contraindications to a cardiac stress test and those who did not undergo the two additional tests (exercise testing and echocardiography) were excluded.

Bias control
A single researcher performed the cardiac stress test and another researcher the echocardiogram. None of them knew the result of the other diagnostic procedure. The additional tests were performed in the morning hours, in air-conditioned rooms, and within a week after enrolling the subjects.

Initial Consultation
At the initial consultation the primary data collection form was filled out. It included general data such as name, age in years, sex and skin color; and weight in kg, height in cm, body mass index (BMI), calculated by the formula: weight in kg divided by the square of height in meters. It allowed the classification of subjects in three groups, normal weight (18.5 to 24.9 kg/m^2, n=50) who were the control group, overweight (25-29.9 kg/m^2, n=60) and obese (≥30 kg/m^2, n=60). Waist circumference was measured (increased >102 cm in men and >88 cm in women) as well as hip circumference. Waist/hip ratio (normal <1 in men and <0.85 in women) was also calculated[6]. Besides, the associated risk factors were determined and the values of the variables obtained in the cardiac stress test and echocardiogram were included.

Cardiac stress test
It was performed in a cycle ergometer, using the diagnostic test protocol that starts at 25 watts and load increments every 2 minutes, non-stop, in the ERGOCID-AT, a machine of domestic manufacture (ICID, Combiomed). Variables were recorded at rest and during maximum effort. They included heart rate (HR), systolic blood pressure (SBP) and diastolic (DBP), rate-pressure product at maximum effort, tolerated METs, exercise time and functional class, according to the New York Heart Association (NYHA). The whole procedure was performed according to the normal rules for cardiac stress tests[7].

Echocardiography
An echocardiographic study, two-dimensional and M-mode echocardiography, was performed with an Aloka alpha-10, of Japanese manufacture. A 3.5 MHz transducer was placed on the chest, in the fourth intercostal space of the left sternal border, and the longitudinal axis of the heart was visualized, obtaining the following variables of the left ventricle (LV): diastolic diameter (LVDD), systolic diameter (LVSD), thickness of the interventricular septum (IVS) and of the posterior wall in diastole (PWD), ejection fraction (LVEF) and fractional shortening (FS). These measurements allowed the calculation of LV mass (LVM) and mass index (LVMI) through the classical formulas[8]:

$$LVM = 1.04\ [(LVDD + LVPWD + IVS)^3 - LVDD^3] - 13.6$$

$$LVMI = LVM/\text{body surface area}$$

For the statistical analysis, the information was digitized in a Microsoft Access 2010 database, and the Epidat software, version 3.1, was used for data processing. Mean ± standard deviation was calculated for quantitative variables, and for qualitative variables the number of observed frequencies and its percentages.

A comparison test of independent means was performed using Student's t statistic and a hypothesis testing of comparison of proportions by the Z statistic between groups of normotensive subjects vs. the overweight and obese, and between overweight subjects and obese subjects. Statistical significance was $p < 0.05$, with a confidence interval of 95%.

RESULTS

General characteristics of the sample
Although there was a slight predominance of women in all groups and the highest percentage of subjects were white, there were no significant differences in relation to age, sex and color of the skin (**Table 1**).

As expected, there were differences in body weight, BMI, waist circumference, hip circumference and waist/hip ratio, with a significant increase in the group of obese subjects whose average time of overnutrition was 9 ± 5 years, while in the overweight group it was 4 ± 3 years.

In the group of normal weight subjects, waist circumference was within the normal limits in all women (80 ± 7 cm); and only in one man (2%) it was above

Table 1. General characteristics of the sample. Normal weight, overweight and obese subjects. General Calixto García University Hospital, 2009-2012.

Variables	Normal weight n=50	Overweigh t n=60	Obese n=60
Age (years)	43 ± 12	46 ± 10	45 ± 9
Sex [n (%)]			
Female	28 (56)	31 (51,7)	32 (53,3)
Male	22 (44)	29 (48,3)	28 (46,7)
Color of skin [n (%)]			
White	26 (52)	30 (50)	35 (58,3)
Black	7 (14)	9 (15)	4 (6,3)
Mixed	17 (34)	21 (35)	21 (35)
Weight (kg)	64 ± 10	77 ± 9 **	107 ± 21 **
Height (cm)	167 ± 9	167 ± 10	164 ± 8
BMI (kg/m^2)	22,6 ± 1,9	27,6 ± 1,5**	39,3 ± 6,7**
Abdominal circumference (cm)	84 ± 9	94 ± 7**	117 ± 14**
Hip circumference (cm)	96 ± 8	106 ± 9**	122 ± 15**
Waist/hip ratio	0,89 ± 0,15	0,91 ± 0,14	0,95 ± 0,1*
Time of overnutrition (years)	-	4 ± 3	9 ± 5

Source: Database
* p <0.01 obese vs. normal weight,
** p <0.001 obese vs. normal weight, obese vs. overweight y overweight vs. normal weight.
The values of quantitative variables are expressed as mean ± standard deviation. Sex and skin color are in number of observed frequencies and percentage.

Table 2. Cardiovascular risk factors in the subjects of the study.

Variables	Normal weight n=50		Overweight n=60		Obese n=60	
	Nº	%	Nº	%	Nº	%
Sedentary life style	15	30,0*	36	60,0**	47	78,3***
Adding salt to food	5	10,0	11	18,3*	32	53,3*
Hypertension	19	38,0	31	51,7	28	46,7
Smoking	5	10,0	11	18,3	16	26,7
Dyslipidemia	3	6,0	7	11,7	6	10,0
Diabetes mellitus type II	0	0,0	1	1,7**	9	15,0***

* p <0.001 normal weight vs. overweight,
** p <0.01 normal weight vs. obese,
*** p <0.05 overweight vs. obese.

102 cm, with mean values in this sex of 88 ± 9 cm (non-tabulated data). In 24 overweight women (40%) and 6 overweight men (10%), increased values were found with average figures of 92 ± 7 cm and 96 ± 8 cm, respectively. In the obese group, this variable was above 88 cm in most women (n=32, 53.3%), 112 ± 12 cm, while abnormal values (121 ± 16 cm) were found in 26 men (43.3%).

The waist/hip ratio showed similar results, because in the group with normal weight, values higher than normal were found in 6 women (12%) and 2 men (4%); while in the overweight group there were 16 women (26,7%) and 3 men (5%) with values higher than normal and in the obese group it increased to 20 among women (33.3%) and 21 (35%) among men.

Cardiovascular risk factors

Among the cardiovascular risk factors (**Table 2**) there was a predominance of sedentary lifestyle, HTA and adding salt to food in the groups with overnutrition (overweight and obese subjects). With regard to a sedentary lifestyle, significant differences were found between normal weight and overweight subjects (Z=4.89; p=0.00001, 95% CI), normal weight and obese subjects (Z=2.94; p=0.003, 95% CI), and overweight vs. obese subjects (Z= 1.97; p=0.04, 95% CI). Adding salt to food also showed highly significant differences between the normal weight and obese groups (Z=4.58; p=0.00001, 95% CI), and between the overweight and obese groups (Z=3.8; p=0.0001, 95% CI).

Type 2 DM, which was only found in the groups with overnutrition, showed significant differences in normal weight vs. overweight subjects (Z=2.5; p=0.01, 95% CI) and vs. obese subjects (Z=2.31; p=0.02, 95% CI).

Exercise testing

The mean and standard deviation of the variables obtained during exercise testing are shown in **Table 3**. The HR at rest did not differ among the three groups, but when assessing HR at maximum effort it was observed that the obese group has a lower value, which differs significantly compared with normal the weight group (t=3.99; p=0.0001, 95% CI) and the overweight group (t=2.59; p=0.01, 95% CI).

Table 3. Variables of the exercise test in the subjects of the study.

Variables	Normal weight n=50	Overweight n=60	Obese n=60
HR at rest (Beats/min.)	84 ± 15	82 ± 15	86 ± 13
HR at maximum effort (Beats/min)	164 ± 14*	160 ± 18	151 ± 20**
Predicted maximum HR (%)	92,1 ± 5,9	91,1 ± 10,1	85,7 ± 11,3
Baseline SBP (mmHg)	120 ± 12	124 ± 15	130 ± 14**
Baseline DBP (mmHg)	76 ± 9	79 ± 9	83 ± 7**
SBP at maximum effort (mmHg)	173 ± 24	189 ± 27***	200 ± 25*,¤
DBP at maximum effort (mmHg)	91 ± 12	98 ± 12***	104 ±12*,**
RPP at maximum effort	28483 ± 5053	30379 ± 6518	29687 ± 5053
Time of exercise (minutes)	8 ± 2	8 ± 2	9 ± 2
Energy consumption (METs)	8,3 ± 1,7*	7,8 ± 2,1	5,8 ± 1,3**
Chronotropic incompetence (n, %)	2 (4)*	7 (11,7)	25 (41,7)**

The values of quantitative variables are expressed as mean ± standard deviation.
* p<0.0001 normal weight *vs.* obese,
** p <0.01 overweight *vs.* obese,
*** p<0.001 normal weight *vs.* overweight,
¤ p <0.05 overweight *vs.* obese,
Legend. HR: heart rate, SBP: systolic blood pressure, DBP: diastolic blood pressure, RPP: rate-pressure product.

Twenty-four obese subjects (40%) did not reach 85% of the predicted maximum HR due to a hypertensive response to exercise (n=5, 20.8%) and physical exhaustion (n=19, 79.2%).

Another important hemodynamic variable was the baseline blood pressure and blood pressure at maximum effort. The SBP and DBP values were increasing from the group with normal weight to the obese group, which had an average SBP within the range that is regarded as mild hypertensive response to exercise. Significant differences in this variable were found between all groups: normal weight vs. overweight subjects (t=3.28; p=0.001, 95% CI), normal weight vs. obese subjects (t=5.76; p=0.00001, 95% CI) and overweight vs. obese subjects (t=2.31; p=0.02, 95% CI).

Similarly, there were significant differences between all groups in the DBP at maximum effort: normal weight vs. overweight subjects (t=3.04; p=0.002, 95% CI), normal weight vs. obese subjects (t=5.65, p=0.00001, 95% CI) and overweight vs. obese subjects (t=2.7; p=0.007, 95% CI).

The chronotropic incompetence was present in obese individuals in a greater percentage, with 41.7%, due to causes that led to the suspension of the test before reaching 85% of predicted maximum HR: fatigue (n=18), dyspnea (n=3), dizziness (n=2), frequent premature ventricular complexes (n=2).However, in overweight and normal weight subjects it was found only in 11.7 and 4%, respectively, due to exhaustion. When making comparisons of proportions for independent samples, significant differences between normal weight and obese subjects were found (Z=4.34; p=0.00001, 95% CI), as well as in overweight vs. obese subjects (Z=2.57; p=0.003, 95% CI).

Regarding physical fitness variables (exercise time, energy consumption, rate-pressure product at maximum effort and functional class), a significant decrease was observed in the energy consumption of obese compared to normal weight subjects (t=8.52; p=0.00001, 95% CI) and to overweight subjects (t= 6.27; p=0.00001, 95% CI).

In our study, the exercise time and rate-pressure product at maximum effort did not differ between groups.

Moreover, in the analysis of the functional classes (**Figure 1**), it was observed that the group with normal weight had the highest percentage in the normal functional class (56%), with significant differences with

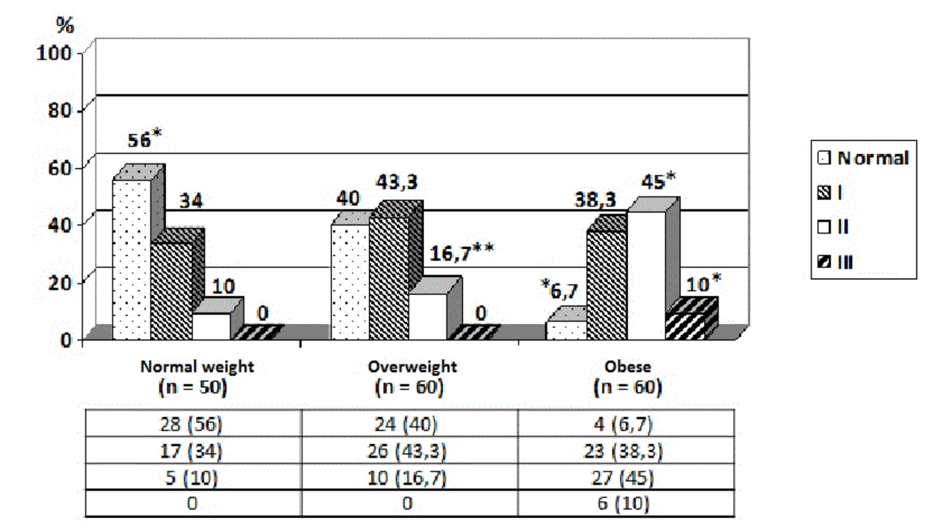

Figure 1. Functional classes according to the exercise test in the subjects of the study.

obese subjects (Z=5.46; p=0.00001, 95% CI), and between overweight and obese subjects (Z = 4.10; p = 0.00001, CI = 95%).

In the obese group, 83.3% of subjects were in classes I and II (38.3 and 45%, respectively). However, significant differences were found in class II between normal weight and obese subjects (Z=3.81; p=0.00001, 95% CI) and overweight vs. obese subjects (Z=3.16; p=0.001, 95% CI).

Class III was found only in the obese group (n=6, 10%).

Echocardiography

In the echocardiogram, the structure and systolic function of the heart showed a general increase, from subjects with normal weight to obese subjects (**Table 4**), in the LV diastolic and systolic diameters, and in the thickness of the PWD and the IVS.

There were significant differences in the LVDD between normal weight and overweight subjects (t=2.42; p=0.01, 95% CI) and between normal weight and obese subjects (t= 4.03; p=0.0001, 95% CI), and in the LVSD between normal weight and obese subjects (t=3.1; p=0.02, 95% CI) and between overweight and obese subjects (t=2.31; p= 0.02, 95% CI).

With regard to PWD, differences between all groups were observed: normal weight vs. overweight subjects (t=2.07; p=0.04, 95% CI), normal weight vs. obese subjects (t=5.34, p=0.0001, 95% CI) and overweight vs. obese subjects (t=2.8, p= 0.005, 95% CI). Similarly, when comparing the IVS, differences were found between the normal weight group and the subjects with overnutrition (normal weight vs. overweight [t=3.99; p=0.0001, 95% CI] and normal weight vs. obese subjects [t=5.19; p=0.0001, 95% CI]). There were no differences in this variable between the overweight and obese groups.

The LV ejection fraction and fractional shortening were not statistically different between the groups.

The variables LVDD, PWD and IVS are part of the mathematical equation for calculating the LVM, and

Table 4. Variables of the echocardiography in the subjects of the study.

Variables	Normal weight n=50	Overweight n=60	Obese n=60
LV diastolic diameter (mm)	45 ± 3.5	46,8 ± 4,1*	48,3 ± 4,9**
LV systolic diameter (mm)	29,1 ± 3***	29,4 ± 4,6	31,3 ± 4,3***
Posterior wall (mm)	9,2 ± 1,4***	9,8 ± 1,7*	10,6 ± 1,4**
Septum (mm)	9,2 ± 1,5	10,3 ±1,6**	10,6 ± 1,4**
Ejection fraction (%)	65,4 ± 5,9	63,3 ± 7	62,6 ± 6
Fractional shortening (%)	35,8 ± 5,6	36,6 ± 5,7	34,9 ± 5,8
Left ventricular mass (g)	159 ± 43,1**	196,8 ± 54,6**	222,8 ± 64,9***
LV mass index (g/m^2)	93,8 ± 26,6	104 ± 29,2	102,7 ± 26,8

The values of variables are expressed as mean ± standard deviation.
* p<0.01 normal weight *vs.* overweight,
** p<0.001 normal weight *vs.* obese,
*** p<0.05 normal weight *vs.* obese/overweight and overweight *vs.* obese
Legend. LV: left ventricle.

were somewhat higher in the overnutrition groups (overweight and obese), so that an increase was observed in this variable compared with the normal weight group (196.8 ± 54.6 and 222.8 ± 64.9 g, respectively vs. 159 ± 43.1 g), with significant differences between the three groups: normal weight vs. overweight subjects (t=4.03; p=0.0001, 95% CI), normal weight vs. obese subjects (t=6.13; p=0.00001, 95% CI) and overweight vs. obese subjects (t=2.37, p=0.01, 95% CI).

DISCUSSION

In the demographic variables, it was observed that females predominated in the three groups, which could be explained by an increase in the population of subjects with overnutrition among women. This situation is shown in the data of the second national survey on risk factors for atherosclerosis, where there is a higher percentage of women with a BMI greater than 30 kg/m^2 (15.44%) compared to men (7.92%), as well as in the group with a BMI between 25 and 29, 9 kg/m^2, which were 31.5 and 29.7%, respectively[3].

The BMI quantifies the excess weight in relation to height, and allows the classification of individuals in different categories. However, in individuals with values greater than or equal to 25 kg/m^2, it does not specify if it is due to fat or muscle development. Still, it is widely used as an index, and enables the classification of subjects as we did in our study.

The waist circumference and the waist/hip ratio are currently more important variables to assess abdominal obesity, body fat distribution, insulin resistance and the risk of cardiovascular disease[5].

Increased waist circumference has been associated with atherogenic risk factors such as dyslipidemia, HT and insulin resistance, which forms the so-called metabolic syndrome that plays a crucial role in the pathogenesis of atherosclerosis[9].

In Cuba, there is a great mixture of people and the use of the values of other populations and ethnic groups is not entirely correct as cut-off points. However, the ATP III criteria may be valid as long as others are not available.

A recent study conducted in adults over 50 years in Sanlúcar de Barrameda, Spain, where central obesity predominated over other anthropometric variables, found out that in individuals with BMI greater than 27 kg/m^2 the waist circumference was altered in 95.4% of women and in 84.5% of men[10]. This is consistent with our results, where women predominated in the waist circumference larger than 88 cm.

A sedentary lifestyle favors a gaining energy imbalance, contributing to overweight and obesity. Sedentary individuals predominate in other studies, as the one published in 2009 by Sánchez León *et al*[11], where 107 patients were studied at the Héroes del Moncada polyclinic in the Revolution Square, with ages between 30 and 69 years, of which 95.1% of those with metabolic syndrome were sedentary. In this group, overweight/obesity was observed in 77% of subjects.

Although the World Health Organization recommends a daily intake of salt for adults not higher than 5 grams, the Cuban population tends to add it to food after cooking, as was demonstrated in our study, mainly in overweight and obese subjects. Its prolonged and excessive consumption causes water retention and therefore, increased weight, which overloads the work of organs such as the heart, liver and kidneys, with increased risk of HT[12]. Another risk factor linked to obesity is HT.

A study conducted in 229 women from 4 medical consulting offices of the 19 de abril Polyclinic in the Plaza de la Revolution, found that patients with abdominal circumference ≥ 88 cm and high BMI had a higher percentage of HT[13].

Exercise testing

With regard to the results of the exercise test, it was observed that obese subjects had a lower HR at maximum effort than normal weight and overweight individuals. This was probably related to the phenomenon that obese subjects should mobilize a greater amount of fat mass during exercise, and energy expenditure increases, favoring an earlier exhaustion. There are also respiratory disorders associated with obesity, such as decreased functional capacity, decreased expiratory reserve volume, and increased demand for ventilation and respiratory effort, therefore, a pathophysiological state of hypoventilation occurs[14].

Although no pulmonary function tests were performed, and it was not the objective of the research, the phenomenon of hypoventilation linked to increased energy expenditure may have helped to limit the exercise in obese subjects and, therefore, the HR at maximum effort was lower in obese subjects compared to the other groups.

Blood pressure increases during exercise, mainly SBP, while DBP remains at values close to the state of rest or with minimal increases (up to 110 mmHg); and it may even decrease slightly.

A study by Cabrera *et al*[15] reported an abnormal exercise pressor response in 88% of prehypertensive subjects, and considered that it was the result of a sedentary lifestyle and high body weight.

Another study conducted in Cuba, with 98 workers of the Medical University of Cienfuegos, found that 65.7% of subjects with a BMI equal to or greater than 25 kg/m^2 had cardiovascular hyperreactivity, and showed that the risk of having this exaggerated blood pressure response was 3.75 times higher in these individuals compared to normal weight individuals[16]. These data support our results, where the hypertensive response to maximum effort occurred in subjects with overnutrition in a higher percentage.

Regarding the results, functional capacity variables, the main finding was the reduction of energy consumption as BMI increased. The METs achieved show indirectly the oxygen consumption, because to find them we use O_2 consumption in basal conditions and weight, which is not individualized, but part of a comprehensive formula. The American Heart Association suggests that in individuals between 18-60 years (which is consistent with that observed in our sample), in the case of men, 9 to 12 METs are considered optimal, and 8-10 METs for women.

A comment that should be considered in relation to the exercise test is that although it has proven useful in many ways, its reliability ranges between 75-85%, and there is a level of subjectivity in assessing symptoms such as muscle fatigue, dyspnea or others that are express by the subject. However, if there were measurements (which are not available in our laboratory) such as the level of lactic acid or respiratory reserve by spirometry, the degree of cardiovascular fitness could be determined with more accuracy.

Gulati and his team[17] evaluated the chronotropic response through different variables, and one of them agreed with our definition, that is, the inability to reach values greater or equal to 85% of the predicted HR for the age. The results of this investigation showed that the chronotropic incompetence presented in subjects with older age and higher BMI and total cholesterol.

Echocardiogram

When the state of body adiposity goes on in time, it causes changes in the structure of the heart. A study conducted in 48 obese subjects compared with 25 normal weight subjects showed increased LV dimensions and increased LVEF[18].

This is consistent with our findings in relation to the structure of the heart, because the subjects with overnutrition had higher values of LVDD, LVSD, IVS and LVPWD, which implies an increase in LVM, but differ regarding LVEF, since our subjects had a lower ejection fraction as BMI increased, although within normal parameters.

CONCLUSIONS

Physical capacity deteriorates as body mass index increases even with normal systolic left ventricular function.

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