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ORIGINAL

Relationship between blood pressure levels and body mass index values in 41,093 ukrainians people

Relación entre los niveles de presión arterial y los valores del índice de masa corporal en ucranianos

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Abstract

Introduction: Arterial hypertension and excess weight are two important public health problems that are increasingly affecting the world population, both in developed and developing countries. The aim of this study is to relate blood pressure values to body mass index (BMI) values in a group of people from Ukraine.
Material and methods: Cross-sectional study in 41,093 Ukrainians in which the relationship between blood pressure and BMI was assessed. BMI is classified according to WHO criteria into 8 types ranging from underweight to type IV obesity.
Results: There is a direct relationship between blood pressure values and BMI values in such a way that as BMI increases, blood pressure values increase in parallel. Age after 50 years, male sex, belonging to social class III and obesity increase the risk of presenting arterial hypertension.
Conclusions: There is a relationship between BMI and blood pressure values in the Ukrainian population.

Keywords: Hypertension, body mass index, obesity, social class.

Resumen

Introducción: La hipertensión arterial y el exceso de peso son dos importantes problemas de salud pública que cada vez afectan más a la población mundial, tanto en los países desarrollados como los que están en vías de desarrollo. El objetivo de este estudio es relacionar los valores de tension arterial con los valores de índice de masa corporal (IMC) en un colectivo de personas de Ucrania.
Material y métodos: Estudio transversal en 41.093 ucranianos en los que se valora la relación existente entre la presión arterial y el IMC. El IMC se clasifica según los criterios de la OMS en 8 tipos que van de bajo peso a obesidad tipo IV.
Resultados: Existe una relación directa entre los valores de tension arterial y los valores de IMC de manera que a medida que se incrementa el IMC aumentan paralelamente los valores de tension arterial. La edad a partir de 50 años, el sexo masculine, pertenecer a la clase social III y la obesidad incrementan el riesgo de presentar hipertensión arterial.
Conclusiones: Existe relación entre los valores de IMC y los valores de tension arterial en población ucraniana.

Palabras clave: Hipertensión, índice de masa corporal, obesidad, clase social.

Introduction

Arterial hypertension (HT) refers to sustained systolic and/or diastolic blood pressure. This pathology is considered the most common chronic disease, affecting 42.6% of the Spanish adult population[1]. It is the leading cause of morbidity and causes the greatest number of circulatory system consultations, and is considered the most important risk factor for cardiocerebrovascular disease, being frequently associated with other risk factors such as age, sex, obesity, smoking, sedentary lifestyle, alcohol and dyslipidemias[2,3].

Obesity is a chronic disease that has greatly increased in prevalence in recent decades and has become an important public health problem. It is defined as excess body weight due to the accumulation of adipose tissue, although the most commonly used formula is the body mass index (BMI), the quotient between weight in kilograms and height in meters squared. A value higher than 30 is indicative of obesity[4].

Different studies, both cross-sectional[5,6] and longitudinal[7], have shown a positive relationship between obesity and blood pressure. Excess weight increases the risk of HT by up to six times, as does a BMI above 27. Every 10 kg of weight gain increases systolic blood pressure (SBP) by 2-3 mmHg and diastolic blood pressure (DBP) by 1-3 mmHg[8].

It is very important to know this association between blood pressure and BMI in order to establish preventive programs and treatment strategies based on changes in dietary and hygienic habits, so that the influence of a decrease in BMI on the decrease in blood pressure figures can be demonstrated[9].

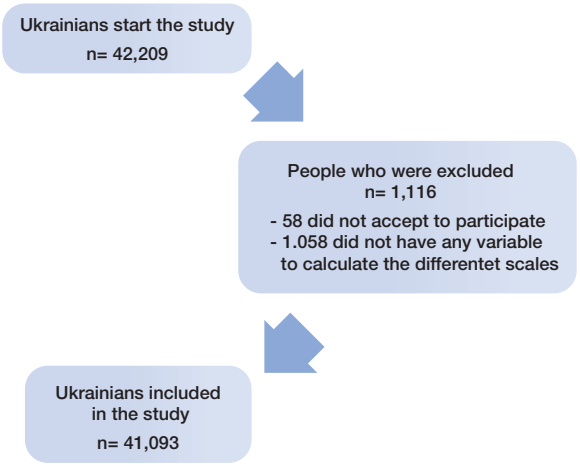
Therefore, the aim of this study was to determine the relationship between BMI and SBP and DBP values in a large group of workers.

Materials and methods

Study design

A retrospective and cross-sectional study was carried out in 421,625 Spanish workers between January 2019 and June 2020. The workers were selected based on their attendance to periodic occupational medical examinations. 418,343 (246,061 men and 172,282 women) finally entered the study. The workers finally included in the study and the reasons for exclusion are presented in the flow chart. (See **figure 1**)

Figure 1: Flow chart of the study participants.



Inclusion criteria:

- Belongs to one of the participating companies.
- Agree to participate in the study and consent to the use of the data for epidemiological purposes.
- Not less than 18 years of age and not more than 69 years of age.
- Have the parameters to calculate body mass index (BMI) or the presence of hypertension.

The anthropometric, clinical and analytical measurements were carried out by the healthcare professionals of the different occupational health units that participated in the study, after standardizing the measurement techniques.

To measure weight (in kilograms) and height (in cm), a height bar scale (model: SECA 700) with an added SECA 220 telescopic height bar was used. BMI is calculated by dividing weight by height in meters squared and was classified according to SEEDO criteria[10].

Blood pressure was measured with a calibrated OMRON M3 automatic sphygmomanometer after 10 minutes of rest. Three measurements were taken at one-minute intervals, obtaining the mean value of the three. The JNC-7 criteria were used to classify blood pressure[11].

An individual was considered a smoker if he/she had regularly consumed at least 1 cigarette/day (or the equivalent in other types of consumption) in the last month, or had quit smoking less than 12 months ago.

The social class was determined from the 2011 National Classification of Occupations (CNO-11) and based on the proposal made by the Spanish Society of Epidemiology[12]. We opted for classification into 3 categories: Class I. Directors/managers, university professionals, athletes and artists. Class II. Intermediate occupations and self-employed workers without employees. Class III. Unskilled workers.

Statistical analysis

A descriptive analysis of the categorical variables was carried out, calculating the frequency and distribution of responses for each of them. For quantitative variables, the mean and standard deviation were calculated, and

for qualitative variables the percentage was calculated. A bivariate association analysis was performed using the x^2 test (with a correction with the Fisher's exact statistical test, when conditions required so) and a Student's t-test for independent samples. For the multivariate analysis, binary logistic regression was used with the Wald method, with the calculation of the Odds-ratio and the Hosmer-Lemeshow goodness-of-fit test was performed. Statistical analysis was performed with the SPSS 27.0 program and a p value of <0.05 was considered as statistically significant.

Considerations and ethical aspects

All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 2013 Declaration of Helsinki. All patients signed written informed consent documents prior to participation in the study.

Results

The anthropometric, clinical, and analytical characteristics of the sample are presented in **table I**. A third of all workers of both sexes were smoker. All parameters show more unfavorable values in males. The majority of workers (75.9%) belong to social class III.

The **table II** shows that in both men and women the SBP and DBP values increase as the BMI values increase. In both sexes the differences observed for SBP and DBP are statistically significant.

The **table III** shows a prevalence of arterial hypertension (sum of AHT 1 and 2) that increases with increasing BMI. This trend is observed in both men and women. The prevalence of HT is higher in men.

In the multivariate analysis using binary logistic regression, the covariates established were male sex, age over 50 years, belonging to social classes II or III, and being obese. The variables that most increased the risk of presenting arterial hypertension were age over 50 years (OR 3.59 95% CI 3.53-3.65) and obesity (OR 3.29 95% CI 3.23-3.35). The complete data can be found in **figure 2**.

Table I: Sociodemographic, anthropometric, analytical and clinical characteristics of workers.

	Women n=16,923 Mean (SD)	Men n=24,170 Mean (SD)	Total n=41,093 Mean (SD)	p-value
Age	39.6(10.8)	40.6 (11.1)	40.2 (11.0)	<0.0001
Height	161.8 (6.5)	174.6 (7.0)	169.4 (9.3)	<0.0001
Weight	66.2 (14.0)	81.4 (14.7)	75.1 (16.2)	<0.0001
BMI	25.3 (5.2)	26.7 (4.5)	26.1 (4.8)	<0.0001
Waist circumference	74.8 (10.6)	86.2 (11.1)	81.5 (12.2)	<0.0001
SBP	117.4 (15.7)	128.2 (15.5)	123.7 (16.5)	<0.0001
DBP	72.6 (10.4)	77.8 (11.0)	75.6 (11.0)	<0.0001
Total cholesterol	190.6 (35.8)	192.6 (38.9)	191.8 (37.7)	<0.0001
HDL-c	56.8 (8.7)	50.3 (8.5)	53.0 (9.1)	<0.0001
LDL-c	116.1 (34.8)	118.0 (36.7)	117.2 (35.9)	<0.0001
Triglycerides	89.1 (46.2)	123.7 (86.4)	109.5 (74.6)	<0.0001
Glycemia	87.8 (15.1)	93.3 (21.3)	91.0 (19.2)	<0.0001
	Percentage	**Percentage**	**Percentage**	**p-value**
18-29 years	20.7	18.8	19.6	<0.0001
30-39 years	29.7	27.6	28.4	
40-49 years	29.6	30	29.9	
50-59 years	16.8	19.7	18.5	
≥60 years	3.2	3.9	3.6	
Social class I	6.9	4.9	5.7	<0.0001
Social class II	23.4	14.9	18.4	
Social class III	69.7	80.3	75.9	
Non smokers	67.2	66.6	66.9	<0.0001
Smokers	32.8	33.4	33.2	

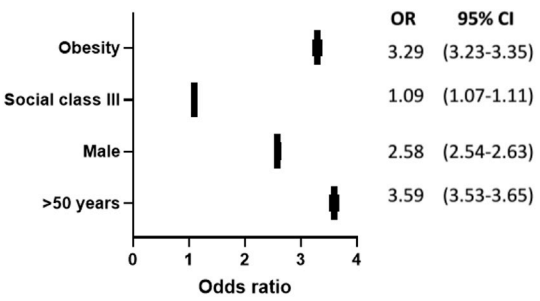
Table II: Mean values of systolic and diastolic blood pressure according body mass index values by sex.

	Men					Women				
		SBP		DBP			SBP		DBP	
	n	Mean (SD)	p-value	Mean (SD)	p-value	n	Mean (SD)	p-value	Mean (SD)	p-value
Underweight	240	118.0 (13.8)	<0.0001	70.3 (9.6)	<0.0001	560	108.6 (13.0)	<0.0001	67.7 (9.0)	<0.0001
Normal	9,153	123.4 (13.8)		73.8 (9.9)		8,866	113.8 (13.9)		70.3 (9.5)	
Overweight I	4,819	127.4 (14.3)		77.4 (10.2)		2,281	118.8 (15.0)		73.4 (10.1)	
Overweight II	5,220	130.6 (15.1)		80.0 (10.5)		2,481	121.4 (15.7)		75.1 (10.3)	
Obesity I	3,606	134.8 (16.1)		82.8 (10.8)		1,846	125.0(16.4)		77.3 (10.5)	
Obesity II	863	138.9 (17.0)		85.2 (11.2)		632	128.5 (17.3)		79.6 (11.1)	
Obesity III	252	143.2 (18.2)		87.9 (11.7)		240	132.1 (18.1)		81.8 (11.2)	
Obesity IV	17	149.4 (19.3)		91.4 (12.4)		17	136.0 (21.1)		84.2 (12.8)	

Table III: Prevalence of values of blood pressure according body mass index values by sex.

	Men								
	Underweight	Normal weight	Overweight I	Overweight II	Obesity I	Obesity II	Obesity III	Obesity IV	
	n=240	n=9,153	n=4,819	n=5,220	n=3,606	n=863	n=252	n=17	
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	p-value
Normal	49.5 (49.1-49.9)	31.5 (31.4-31.6)	20.8 (20.7-20.9)	14.4 (14.3-14.5)	9.2 (9.0-9.4)	5.7 (5.5-6.0)	3.8 (3.4-4.2)	1.2 (0.8-1.6)	<0.0001
Prehypertension	42.5 (42.1-42.9)	53.5 (53.4-53.6)	55.3 (55.2-55.3)	52.9 (52.8-53.0)	46.2 (46.0-46.5)	38.8 (38.6-39.0)	30.4 (30.0-30.8)	22.4 (21.7 (23.1)	
Hypertension I	6.8 (6.5-7.1)	12.7 (12.6-12.8)	19.6 (19.5-19.7)	25.5 (25.4-25.6)	32.4 (32.2-32.6)	37.5 (37.3-37.7)	39.9 (39.5-40.3)	36.2 (35.5-36.9)	
Hypertension II	1.2 (1.0-1.4)	2.3 (2.2-2.3)	4.4 (4.3-4.4)	7.2 (7.1-7.3)	12.2 (12.0-12.4)	18.0 (17.8-18.2)	25.9 (25.5-30.3)	40.2 (39.4-41.0)	
	Women								
	n=560	n=8,866	n=2,281	n=2,481	n=1,846	n=632	n=240	n=17	
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	p-value
Normal	74.4 (74.2-74.6)	61.4 (61.3-61.5)	46.0 (45.9-46.1)	38.7 (38.5-38.9)	28.8 (28.6-29.0)	21.4 (21.1-21.7)	14.4 (14.0-14.8)	13.1 (12.1-14.2)	<0.0001
Prehypertension	22.7 (22.5-22.9)	32.3 (32.2-32.4)	41.3 (41.2-41.4)	44.3 (44.1-44.5)	47.8 (47.6-48.0)	47.2 (46.9-48.5)	45.8 (45.3-46.3)	36.6 (35.4-37.8)	
Hypertension I	2.5 (2.3-2.7)	5.3 (5.2-5.4)	10.3 (10.2-10.5)	13.7 (13.5-13.9)	18.0 (17.8-18.2)	23.3 (23.0-23.6)	27.0 (26.4-27.6)	29.7 (28.5-30.9)	
Hypertension II	0.4 (0.3-0.5)	1.1 (1.0-1.1)	2.4 (2.3-2.5)	3.3 (3.2-3.4)	5.3 (5.2-5.5)	8.2 (7.9-8.5)	12.8 (12.3-13.3)	20.6 (19.4-21.8)	

Figure 1: Binary logistic regression.



Discussion

The most outstanding results of our study are the increase in the prevalence of arterial hypertension parallel to the increase in BMI, from a prevalence of 2.9% in women and 8% in men with low weight to a prevalence of 60.3% in women and 76.4% in men with type IV obesity. Another interesting fact is that obesity increases the risk of presenting arterial hypertension more than 3 times.

Obesity and the excess distribution of visceral fat produce various alterations at the hormonal, inflammatory and endothelial levels. These alterations stimulate a series of mechanisms that induce hypertension and increase cardiovascular morbidity[13]. Most hypertensive patients are overweight or obese. A study conducted in Finland found that more than 85% of hypertension occurs in subjects with a BMI> 25 kg/m^2 [14]. In the same way that obese subjects have a tendency to develop hypertension, hypertensive subjects appear to be prone to weight gain. Thus, the relationship between obesity and hypertension becomes a "two-way street", as there is evidence that future weight gain is significantly higher in hypertensive patients than in normotensive subjects[15].

In 2017, a large global analysis was published regarding BMI trends in different counties between 1975 and 2016. During that period, no changes were detected in the BMI of European children, but increased in Central Latin America, Polynesia and Micronesia for these. The prevalence of obesity was greater than 20% in several countries in Polynesia and Micronesia, the Middle East and North Africa, the Caribbean, and the United States[16]. For what we believe it is interesting to describe the results of our study population.

Different studies, some older, such as those of Brown et al[17] in the North American population, and other more recent ones, such as those of Hossain[18] in Bangladesh or those of Landi et al[19] in almost 8,000 Italian adults, found an association between BMI and blood pressure values similar to that obtained by us. A Canadian study[20] conducted in almost 20,000 persons with an age range similar to ours and another conducted in an exclusively female North American working population[21] also with ages similar to ours also found a positive association between BMI values and blood pressure figures. The same occurs with a study published on the Chinese population, in a sample of 15,296 participants over 15 years of age. It also showed a correlation between BMI and VAI (Visceral adiposity index with prehypertension and hypertension, BFP (Percentage of body fat) with prehypertension and abdominal obesity with hypertension[22]. A recent Pakistani study[23] conducted in a young population (mean age 33.5 years) also found a relationship between BMI and arterial hypertension.

Strengths and limitations

The strengths of the study include the large sample size in both men and women and the inclusion of the effect of social class in the multivariate analysis. The most important limitations of the study are that the study population is a working population between 18 and 69 years of age, which means that persons aged 70 years and older are not represented, and that the study was carried out in the Ukrainian population, which could make it difficult to extrapolate the results to other geographical settings.

Conclusion

There is a close relationship between BMI values and systolic and diastolic blood pressure values in this group of workers.

Interests conflict

The researchers declare that they have no conflict of interest.

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