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Association between Obesity and Metabolic Anomalies in a Population in Eastern Algeria

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Abstract

Obesity is defined by an excess of fat and can be considered as a heterogeneous, multifactorial phenotype, determined by genetic factors, environmental factors, and gene-environment interaction. A high body mass index is an important risk factor in the development of much comorbidity dominated by metabolic disorders and cardiovascular diseases. The objective of this work was to describe the obesity (BMI≥30 kg/m2) and metabolic profile of adults in Constantine. A descriptive cross-sectional survey was conducted and anthropometric and clinical examinations were performed. Biochemical assays (fasting glucose, triglycerides, total cholesterol, HDL and LDL cholesterol) were performed. In total, 1,143 subjects participated, with the sample comprised of 41.3% men and 58.7% women. The mean body mass index was 27.22, and the overall prevalence of obesity in the sample was 30.9%. Abdominal obesity by the International Diabetes Federation (IDF) was present in 68.15% (83.5% women vs. 46.4% men). The incidence of type 2 diabetes was 42% in the obese subjects. The average number of metabolic complications was greater in the obese than non-obese subjects. Binary logistic regression analysis showed that in men the association between hypercholesterolemia, dyslipidemia, and hypertriglyceridemia was the same, regardless of the participants' BMI. This association increased with BMI in women. With regard to hyperglycemia, the association increased with BMI in men but much more in women. Metabolic abnormalities are more frequent in obese people, increasing their cardiovascular risk, and thus urgent preventive actions need to be taken.

Keywords: Obesity, visceral abdominal obesity, body mass index, diabetes, metabolic abnormalities.

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Introduction

Obesity results from the interaction of genetic, metabolic, behavioral and environmental factors. Considering the rapid increase in its prevalence, there is a tendency to think that it is behavioral and environmental factors rather than biological changes which are playing a key role in this rise [1]. Obesity has become in recent years a major public health problem for our societies. In Algeria, the magnitude of the problem in obesity is not yet well known, but a number of factors are suggestive of the fact that the situation is not very different from that prevailing in countries at the same level of development. Demographically, the Algerian population is composed mostly of young adults (20–59 years representing 41.5%) and the dramatic increase in life expectancy over the past 40 years has seen the gradual ageing of the population and an increase in the burden of chronic diseases. Thus, as in many countries, the status of overweight and obesity is disturbing in our country since 2005, 55.9% of people aged 35–

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70 years were overweight and 21.24% obese [2]. Epidemiological studies have found strong associations between obesity and the onset of certain diseases such as cardiovascular disease and type 2 diabetes. This underlines the need for early identification, to give the best guarantee of increasing the life expectancy of the obese while preserving their social and psychological well-being. In order to characterize our population and determine the prevalence and impact of obesity, our work aims to analyze the association between obesity and the metabolic profile of adults using logistic regression modeling.

MATERIAL AND METHODS

The study area

The study was conducted in the city of Constantine in northeastern Algeria; it is located 439 km from the capital of Algiers. Constantine is the third largest city in Algeria in terms of population, which is around 448,374 inhabitants. The adult population aged 18 plus is 340,428 [3].

Population and sample

We performed a descriptive cross-sectional cluster sample survey among a representative sample of adults, and thus the target population was older Constantine adults. The inclusion criteria were: subjects of both sexes, Constantine residents aged 18 plus, and being present on the day of the survey. The sampling strategy was developed and implemented in collaboration with the National Statistics Office of Constantine (ONS). The sample took into account the geographical division of the municipality into ten distinct areas by population density [3]. Constantine has 10 areas and each area is made up of several districts, thus according to the population of each sector, the number of district to be surveyed has been calculated. Thirty districts were identified and defined geographically, and twenty households from each district were selected. Two persons in each household aged 18 and over were interviewed. A total of 1,200 people aged 18 years and over were surveyed.

Data collection

Data were collected by a trained person in the home of the respondents. For the recruitment, anthropometric measurements were taken: weight (kg) was measured using electronic personal scales (Terraillon France) with an accuracy of 100g; height (cm) was measured in a standing position without shoes using a rolling table (Seca Germany). waist circumference (cm) was performed using non-scalable tape measures graduated to the millimeter; and, hip circumference was measured at the level of the symphysis pubis and the maximum circumference of the hips or buttocks. The corpulence of the patient and degree of obesity were evaluated by the calculation of BMI (kg/m^2) as underweight BMI<18.5, normal 18.5<BMI<25, overweight 25<BMI<30, and obese BMI>30 [4].

Abdominal obesity is indicated using the following factors:

- Waist circumference (WC): this simple clinical measure is important and correlates well with the amount of intra-abdominal fat, which is associated with an increased risk of metabolic and cardiovascular complications. According to the *International Diabetes Federation* (IDF) a WC ≥94cm in men from Europe and ≥80cm in women from Europe is a sign of abdominal obesity [5].

- A ratio between waist and hip circumferences (RWH) of ≥1 in men and ≥0.85 in women is a sign of abdominal obesity [6].

- The ratio for waist circumference/size (RWS) is the circumference of the waist in centimeters divided by the height (size) in

centimeters. Participants whose WSR was ≥0.5cm (for both sexes) were classified as having an increased or high risk of health issues [6].

These parameters are more closely associated with cardiovascular morbidity and mortality [7].

In addition, data collection was carried out through interviews, based on a validated questionnaire which asked about; including different aspects, namely,: personal and family history, the socio-economic context and educational and psychological status, as well as other factors such as smoking, physical activity and diet. Blood samples were taken in heparinized tubes from fasting subjects, intended for a lipid profile and the determination of blood glucose. Samples were taken at the laboratory of the public hospital in Constantine.

Statistical analysis

Data analysis was carried out using SPSS v18 and Microsoft Excel 2007. ANOVA was used to compare means and a Pearson test was adjusted or not to age to compare percentages, and used to calculate the correlation coefficient between the variables studied. A multivariate binary logistic regression was then performed to determine the relationship between each variable and obesity, independently of other variables. Results are presented as odds ratios (OR: odds ratio) with 95% confidence intervals (95% CI), adjusted for age and all other model variables. Logistic regressions were also taken performed separately for the men and women.

RESULTS

From the 600 households initially selected, a total of 1,200 subjects were recruited. Of these, 57 (4.75%) individuals refused to participate or were absent on the day of the survey. A total of 1,143 subjects completed the questionnaire, among them 58.7% women and 41.3% men. The average age was approximately 38.30 years, with 21.30% being aged 18–34. The percentage of married people was 57.23%. Socio-economic level was measured indirectly from the level of education. The percentage of illiterate or primary educated persons was 27.6%. Of the 31.9% of individuals who were active, the majority were men (46.8% vs. 21.5% women).

The average BMI was 27.22, and was significantly higher in women than men; the average WC was 93.8 cm. This measurement increased with age ($p<10^{-3}$). The average RWH was 0.9, and the average WSR was 0.6 (Table 1). The overall prevalence of obesity in the sample was 30.9% (Figure 1), and was significantly higher in women (38.29% vs. 20.76% men OR=2.4 [1.8–3.1] $p<10^{-3}$). Overall, the prevalence of total obesity increased significantly ($p<10^{-3}$) with age 18 and 64 years (18.10% to 41.95%) and fell in the age group 65 years and older (30, 49%). The age group most affected by obesity was 55–64 years.

The participants were asked about lifestyle, in particular the time they undertook physical activities and the number of meals per day; 67.2% of the men and 76.7% of the women were sedentary (did not exercise). The nutritional profile established through a food survey can be characterized by excessive caloric intake, with 82.8% of the subjects consuming more than three meals per day. Excess calories were consumed as snacks and came from fatty and sugary foods. According to BMI, 84.2% of the obese eat more than three meals a day compared to non-obese. There was little difference in the quality of the eating habits of the obese and non-obese participants.

Analysis of the biological data collected revealed that 81.79% of the respondents had a

normal glucose level. The frequency of hyperglycemia increased significantly with age, from 8.33% in those aged 18–24 to 17.3% in those aged 54–64. The frequency of normal cholesterolemia was 71.52%, while that of low HDL cholesterol was 58.25%. The frequency of normal triglyceridemia was 70.35%. The frequency of hypertriglyceridemia increased with age, at 5.95% for those aged 18–24 and 11.36% for those 65 years and over, peaking at 19.23% among persons aged 54–64. The prevalence of diabetes (corresponding to diabetics known and followed plus newly diagnosed diabetics) was 21.91%. The dyslipidemic subjects screened were those who were found to have a cholesterolemia level greater than or equal to 200 mg/dl and a triglyceridemia greater than or equal to 150 mg/dl [5]; their frequency was 6.5% (Table 2). The average number of metabolic complications is greater in obese (BMI ≥30 kg/m^2) than non-obese patients (18.5–24.9 kg/m^2). This difference is statistically very significant ($p<10^{-3}$) (Table 3). The prevalence of hyperglycemia and diabetes in the obese was respectively 27.0 (23.2% ♀ vs. 43% ♂ p= 0.001), 42% (23.2% ♀ vs. 43% ♂ p=0.001). Lipid abnormalities were more common in obese patients with hypertriglyceridemia at 17.8 (19.2% ♀ vs. 11.1% ♂ p=0.5), dyslipidemia at 10.3 (11.8% ♀ vs. 3.7% ♂ p=0.2), hypercholesterolemia at 11.2 (11.2% ♀ vs. 11.1% ♂ p=0.6), and HDL Low Cholesterol at 57.9 (77.3 ♀ vs. 44.4% ♂ p=0.001) (Table 3).

Table 4 presents the results of the logistic regression analysis; after adjustment for socio-economic variables and lifestyle, obesity remains strongly associated with hyperglycemia (8.7 [3.6–21.3] $p<10^{-3}$), hypercholesterolemia (3.6 [1.3–9.9] p=0.01), hypertriglyceridemia (2.7 [1.3–5.6] p=0.01) and dyslipidemia (3.9 [1.2–12.0] p=0.02). The association between hypercholesterolemia, dyslipidemia, and hypertriglyceridemia was the same, regardless of the men's BMI, but it increased with women's BMI. With regard to hyperglycemia, the association increased with BMI in men and was much more so in women.

DISCUSSION

Our results show that obesity (30.9%) is gaining ground, and so is being overweight (32.5%). The change in the latter suggests that more and more of the population will be affected later by obesity. These results are alarming when compared to studies in other countries around the world. In Morocco (2009), 13.3% of the population were obese at the time of the study [9]. In Tunisia [10], obesity was shown to affect 15% of the population, with 40% having excess weight. In 2009, the prevalence of obese French was 14.05% +/- 0.4% [11]. In North America, in 2007–2009, the prevalence of obesity in Canada was 24.1%, which is more than ten percentage points lower than in the United States (34.4%) [11]. Morbid obesity is twice as high in the United States (6.0%) than in Canada (3.1%) [12]. Obesity, especially abdominal obesity, is associated with a set of metabolic complications that increase the risk of developing type 2 diabetes and coronary artery disease [13]. The prevalence of abdominal obesity in this study according to IDF is 68.15% (83.5% in women vs. 46.4% in men OR=2.1 [1.6–2.5] $p< 10^{-3}$). It is interesting to note that, in this sample, based on the thresholds proposed in the literature, more women than men are identified who would be at risk of metabolic and cardiovascular diseases due to an abdominal distribution of adipose tissue. When we consider the difference in mortality and cardiovascular morbidity

between the sexes, this is to the detriment of men. This finding leads to the conclusion that the proposed thresholds for women are probably inadequate.

The results of this study show that metabolic abnormalities are significantly more common in obese patients. The majority of obese persons have at least one metabolic abnormality, and Hatira [13] found that more than two-thirds (67%) had at least one metabolic complication. Glycoregulation disorders in the obese of our sample were dominated by moderate fasting hyperglycemia (34.2%) which could evolve into true type 2 diabetes. The prevalence of type 2 diabetes increases in parallel with that of obesity. Stein and Colditz [14] reported that the risk of type 2 diabetes increased 2.9 times in obese patients aged 20–75 years. In this study, the incidence of type 2 diabetes was 42% in obese subjects and 21.38% in normal weight subjects. In this study, lipid abnormalities were more common among the obese than non-obese. In fact, the obese had a highly atherogenic lipid profile marked by the elevation of LDL cholesterol, total cholesterol, apolipoprotein B, triglycerides and hypo HDLemia [15]. Pi-Sunyer [16] and Lemieux and Després [17] found that hypertriglyceridemia was significantly higher in obese than in non-obese. The Framingham study [18] showed that a 10% increase in body weight is associated with a 0.3 mmol/l increase in cholesterol levels. According to the NHANES II study [19], the relative risk of hypercholesterolemia in obese adults is 1.5 times compared to normoponderal adults. In addition, Formiguera and Canton [20] noted that LDL cholesterol was higher in obese men. Lemieux and Després [17] found that subjects with predominantly visceral obesity have significantly higher levels of apolipoprotein B and a greater hypo HDLemia compared to non-obese subjects.

CONCLUSION

This epidemiological study focused on more than 1,100 adults in Constantine, Algeria. It confirms a high prevalence of obesity (> 30%), in particular in women and especially a worrying prevalence of forms of central obesity with an increase in the frequencies of metabolic abnormalities frequent in the obese. These increase their cardiovascular risk and hamper quality of life. The results suggest a worsening of the epidemiological situation in the future adult population. This underlines the need for early and multidisciplinary management of obesity, and mass preventive measures are therefore essential to curb this worrying phenomenon which affects a young population, just as in many other countries in the Maghreb and many other emerging countries.

Table 1. Summary of key anthropometric variables

Variables	Men	Women	*p*-value
Weight (Average)	74.9	72.9	0.001
Height (Average)	170.7	160.2	$<10^{-3}$
Waist circumference (WC) (Average)	93.1	94.2	$<10^{-3}$
Hip circumference (Average)	97.8	103.1	$<10^{-3}$
WHR (Average)	0.9	0.9	$<10^{-3}$
WSR (Average)	0.5	0.6	$<10^{-3}$
BMI (Average)	25.6	28.4	$<10^{-3}$
Overweight (%)	32.4	32.5	0,7
Obesity I–II (%)	18.6	33.8	0.001
Obesity III (%)	1.7	4.5	0,01
Overall obesity (%)	20.8	38.3	$<10^{-3}$
WC ≥94 ♂ – WC ≥80 ♀ (%)	46.4	83.4	$<10^{-3}$
WC ≥102 ♂ – WC ≥88 ♀ (%)	27.1	69.4	$<10^{-3}$
WHR ≥1♂ – WHR ≥0,85♀ (%)	25.8	87.6	$<10^{-3}$
WSR ≥0.5 ♂and ♀ (%)	69.5	81.7	0.01

p-value of the chi² *p*<0.05*: significant *p*>0.05: not significant
Obesity I: BMI: 30-34,9 Kg/m2 Obesity II: 35-39,9 Kg/m2 obesity III: BMI >40Kg/m2

Table 2. Summary of the main biological variables by sex

Variables	Men %	Women %	*p*-value
Normal glycemia	83.1	81.3	0.9
Moderate hyperglycemia	4.0	4.7	0.9
Hyperglycemia	12.9	14.0	0.9
Diabetes	20.4	22.6	0.7
Normal cholesterolemia	77.4	69.1	0,6
Limit cholesterolemia	16.1	22.2	0.4
Hypercholesterolemia	6.4	8,6	0.4
HypoHDLemia	45.2	78.7	$<10^{-3}$
Normal triglyceridemia	71.8	66.7	0.3
Limit triglyceridemia	19.3	14.9	0.2
Hypertriglyceridemia	8.9	15.3	$<10^{-3}$
Dyslipidemia	4.8	7.0	0.4

Normal glycemia (<110mg/dl), moderate hyperglycemia (110–125mg/dl) and hyperglycemia (≥126mg/dl). Normal cholesterolemia (<200mg/dl), limit cholesterolemia (200–249mg/dl) and hypercholesterolemia (≥250mg/dl). Normal triglyceridemia (<150mg/dl), limit triglyceride (150–199mg/dl) and hypertriglyceridemia (≥200mg/dl)

Table 3. Frequency of metabolic abnormalities in obese and non-obese

	Hyperglycemia	Diabetes	Hypertriglyceridemia	Dyslipidemia	Hypercholesterolemia	Low HDL
Obese	27.0	42.0	17.8	10.3	11.2	57.9
Not obese	13.7	21.9	13.4	6.5	8.0	48.6
p-value	$<10^{-3}$	$<10^{-3}$	0.002	0.001	$<10^{-3}$	0.8

p<0.05*: significant *p*>0.05: not significant

Table 4. Association between BMI category and metabolic abnormalities

		Gender				All		
		Men			Women			
		OR	**IC95%**	**p**	**OR**	**IC95%**	***p***	**OR**	**IC95%**	***p***
Hyperglycemia	18.5<BMI<25	1.0			1. 0			1.0		
	25<BMI<30	1.6 [0.4–10.2]		0.7	2.7 [0.8–8.9]		0.09	2.4 [0.96.6]		0.08
	BMI>30	**21.3 [4.6–12.7]**		**$<10^{-3}$**	**6.6 [2.8—19.2]**		**$<10^{-3}$**	**8.7 [3.6–21.3]**		**$<10^{-3}$**
Hypercholesterolemia	18.5<BMI<25	1.0			1.0			1.0		
	25<BMI<30	2.2 [0.3–13.4]		0.4	2.8 [0.8–11.4]		0.1	2.7 [0.9–7.8]		0.07
	BMI>30	**3.4 [0.5–21.6]**		**0.2**	**3.5 [1.1–12.9]**		**0.01**	**3.6 [1.3–9.9]**		**0.01**
Dyslipidemia	18.5<BMI<25	1.0			1.0			1.0		
	25<BMI<30	5.9 [0.6–55.3]		0.1	1.2 [0.6–5.6]		0.8	2.2 [0.6–7.4]		0.2
	BMI>30	**2.1 [0.2–35.0]**		**0.6**	**3.6 [1.2–12.9]**		**0.01**	**3.9 [1.2–12.0]**		**0.02**
Hypertriglyceridemia	18.5<BMI<25	1.0			1.0			1.0		
	25<BMI<30	1.7 [0.3–5.2]		0.6	2.1 [0.8–5.5]		0.1	1.9 [0.9–4.3]		0.09
	BMI>30	**1.0 [0.3–7.8]**		**0.5**	**2.9 [1.2–6.8]**		**0.02**	**2.7 [1.3–5.6]**		**0.01**

• OR (odds ratio) = 1: no relationship between the risk factor and the disease
• OR> 1 px^2 <0.05: significantly increased risk • OR <1: px^2 <0.05: significantly reduced risk
• px^2> 0.05 no statistically significant relationship can be demonstrated between the factor studied and the disease

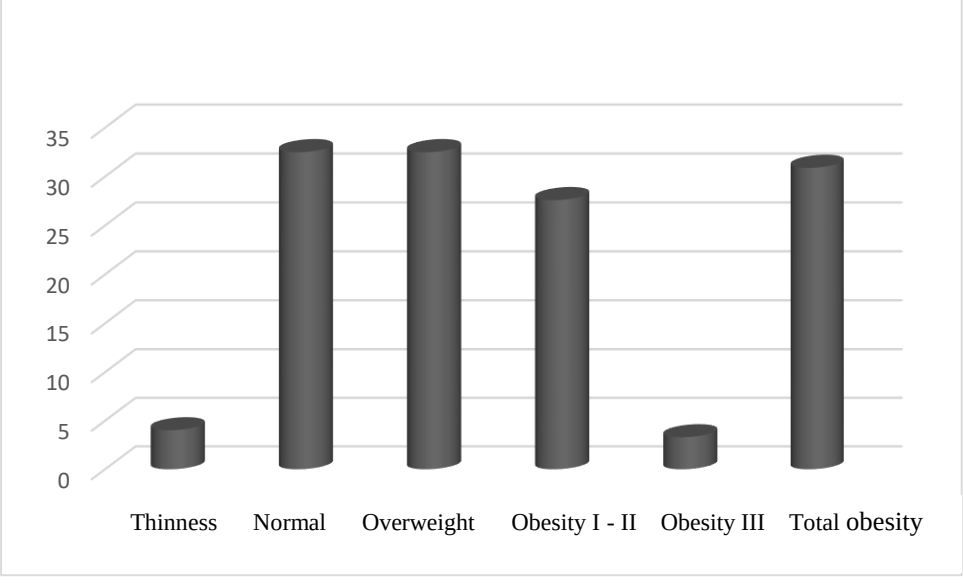

Figure 1. Frequency of BMI classes in individuals aged 18 years and over

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رابطة بين البدانة والتشوهات الأيضية في سكان شرق الجزائر

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الملخص

يتم تعريف السمنة من خلال زيادة الدهون، ويمكن اعتبارها من خلال نمط ظاهري غير متجانس متعدد العوامل، تحدده العوامل الوراثية، والعوامل البيئية والتفاعل بين البيئة والجينات.

إنّ ارتفاع مؤشر كتلة الجسم هو عامل خطر ومهم للإصابة بالعديد من الأمراض التي تهيمن عليها الاضطرابات الأيضية والقلب والأوعية الدموية.

الهدف من هذه الدراسة هو وصف السمنة (مؤشر كتلة الجسم أكبر من 30 كجم / م 2) والمظهر الأيضي للبالغين في قسنطينة، وتم إجراء مسح وصفي مقطعي، وأجريت فحوصات قياسات الجسم، وتم إجراء فحوصات كيميائية حيوية:(الجلوكوز الصائم، الدهون الثلاثية، الكوليسترول الكلي HDL و LDL) في المجموع، شارك في الاستطلاع(1143) شخصًا، تم تقسيمهم إلى ما نسبته : (41.3٪) رجال، و(58.7٪) نساء، وبلغ متوسط مؤشر كتلة الجسم لديهم (27.22)، وبلغ معدل انتشار السمنة في العينة (30.9٪) علمًا أن السمنة في البطن موجودة في (68.15٪) موزعة (83.5٪) نساء مقابل (46.4٪) رجال، وكانت نسبة الإصابة بمرض السكري من النوع (2) (42٪) في الأشخاص الذين يعانون من السمنة المفرطة، وكان متوسط عدد المضاعفات الأيضية أكبر لدى الأشخاص الذين يعانون من السمنة المفرطة، وأظهر تحليل الانحدار اللوجستي الثنائي أن العلاقة بين فرط كوليسترول الدم، وعسر شحميات الدم، وارتفاع شحوم الدم هي نفسها عند الرجال بغض النظر عن مؤشر كتلة الجسم للمشاركين، ويزيد هذا الارتباط مع مؤشر كتلة الجسم عند النساء. في ما يتعلق بفرط سكر الدم، فإن الارتباط يزيد مع مؤشر كتلة الجسم عند الرجال، وأكثر بكثير منه عند النساء، والاضطرابات الأيضية أكثر شيوعًا لدى الأشخاص الذين يعانون من السمنة المفرطة، مما يزيد من مخاطر الإصابة بأمراض القلب والأوعية الدموية؛ لذا يجب اتخاذ إجراءات وقائية عاجلة.

الكلمات الدالة: السمنة، سمنة البطن، مؤشر كتلة الجسم، مرض السكري من النوع (2)، الاضطرابات الأيضية.