Prevalence of obesity and hypertension in the region of Khouribga (Morocco): effects of socio-demographic and lifestyle factors

Hajar El Hendaoui [1], *Mohamed* Mziwira [1,2], and *Rekia* Belahsen[1*]

[1]Training and Research Unit on Nutrition & Food Sciences, Chouaib Doukkali University, School of Sciences, El Jadida, 24000, Morocco
[2]Laboratoire Bio-Géosciences et Ingénierie des Matériaux, École Normale Supérieure, Hassan II University of Casablanca, B. P50069, Ghandi, Casablanca, Morocco

Abstract. Obesity is characterized by an excessive accumulation of body fat is in continuous increase associated with cardiovascular risks and health disadvantages. Objective: The aim was to the study the prevalence and the determining factors of the association of obesity and hypertension in the Moroccan population of Khouribga province hitherto unstudied. A cross-sectional survey was conducted oi 2019 among a random sample of 401 adults of both sexes, from urban and rural areas. Anthropometric parameters and blood pressure were measured. Body mass index (BMI), waist-to-hip ratio (WHR), were calculated, Socio-demographic characteristics and physical activity level are determined. Anthropometric variables are significantly different in women and men. General obesity (BMI>30) was prevalent in 33.1% and abdominal obesity in more than 75%. Both general and abdominal obesity do not show any significant difference between urban and rural areas of residence. Hypertension was present in 35.5% in both sexes, significantly higher in rural men (57%) compared to urbans. Obesity increases with sedentarity. Obesity and hypertension increase with age and manifest themselves beyond the age of 35. Women with more than three children are obese. The present study data show that body weight management is related to origin, age, number of children as parameters associated with obesity. The prevalence of hypertension is associated with severe obesity. Abdominal obesity could be a predictive parameter of hypertension in the Moroccan population of the study province.

1 Introduction

Obesity defined as an abnormal or excessive accumulation of body fat results from a persistent energy imbalance whose regulation involves biological, behavioral and social interactions and can harm the health of individuals. It is prevalent in populations of both developing and developed countries, affecting all age categories regardless of sociodemographic and socioeconomic criteria1 [1, 2]. One of the main complications in obese patients is hypertension [3]. This was estimated at 33.6% by a prospective study carried

*Corresponding author: rbelahsen@yahoo.com

out in 2000 by the Moroccan Ministry of Health. The same rates have been reported in Arab countries around the Mediterranean [4].

The prevalence of overweight and obesity together is 54% in men and 44% in women in France [5], 24.3% and 23.9% in Canada [6] and 24.45% and 27.52% of men and women respectively [7] in the Comorian islands. In the USA, the prevalence of obesity was 36 % in adults between 2011- 2014[8]. In Korea, high prevalences of obesity have been recorded and more marked in men (41.6%) than women (25.6%) [9]. Moreover, abdominal obesity is also highly prevalent, affecting in Spain 53.2% of men and 65.3% of women associated with hypertension among both sexes (58.5% and 44.2% respectively). In Tunisia, high prevalences of abdominal obesity (47.1% of men and 92.7% of women) and hypertension (59.6% and 42.7%) were also recorded in men and women respectively [10]. The same is true for Lebanon where obesity was estimated at 70.6% in men and 34.27% in women [11] with a hypertension rate of around 13.7%. Furthermore, hypertension varies by region, country and income, with the highest prevalence found in the WHO African Region (46%) and the lowest in the WHO Region of the Americas (35%) [12].

Morocco is also experiencing an increase in the prevalence of obesity associated with the demographic, epidemiological and nutrition transitions that are underway in the country, with a significant increase in life expectancy and urbanization rates. Obesity affects women in proportion of about three times more (29%) than men (11%) and is more prevalent in urban areas (22.8%) than in rural areas (14.9%) with disparities according to the provinces, ethnic groups and sex. Indeed, a prevalence of 2.4% for men and 13.3% for women was reported in 2007 in the Amazigh population of the High Atlas [13]and 19.8% and 22.5% in the Souss region[14] in men and women respectively, while it affects 49% of Sahrawi women in Laayoune [15] and 43 % in Smara [16] and 10.1% in Oujda[17]. Between 2000 and 2017, the obesity rate rose from 13.2 to 20% in Morocco, an increase of about 7 points [18]. This is the case of all regions. For example, in El Jadida province, the prevalence of general obesity was 10.1% in 1995 in women and 23.9% in 2001 [19, 20].

Hypertension, a problem associated with obesity, is also widespread in the Moroccan population [21] [22] with varying rates depending on the different provinces. It was estimated at 29.8% in the southern Moroccan population [20] and to 31.7% in the Eastern region (Oujda)[17].

The objective of the present study is to examine both hypertension and obesity and to seek the association of these two health problems in the population of the Chaouïa-Ouardigha region hitherto unstudied, through the example of the Khouribga province in Morocco.

2 Methodology

2.1 The Study population and province

The province of Khouribga, created on July 10th in 1967, is located northwest of the Beni Mellal-Khénifra region, comprising five urban communes and 26 rural communes. The province of is considered one of the largest phosphate mining centers in the kingdom. The area extends over approximately 4250 km2 representing 6% of the total area of the territory, whose population is 542,125 and the density is 127.56 inhabitants per km2. Urbanization rate has reached 69.7% in 2014. The proportion of people under 15 represents 28.1%, that of 15-59 years old is 61.3% and people aged 60 and over represent 10.6%. The percentages of males and females are respectively 48.3% and 51.7% and 50.8% residing in urban areas while 49.2% are in rural areas [23].

2.2 Study sample

This study is a cross-sectional regional survey, conducted in 2019 included a random sample of 400 women and men from the province of Khouribga in Morocco from both rural and urban areas of residence.

2.3 Sociodemographic and socioeconomic characteristics, physical activity and sedentary lifestyle

Several variables were collected to characterize the women and men surveyed, in particular age, the number of pregnancies for women, the number of children and number of people in the household. Walking in minutes, naps in minutes, time spent in front of the screen, time awake and time to sleep at night were used to assess physical activity level and sedentary lifestyle

2.4 Anthropometric measurements

Anthropometric measurements were performed on sampled women and men according to World Health Organization standards. Weight is measured with an electronic scale to the nearest 100g, height, waist circumference (WC) and hip circumference (H) were measured with a measuring tape. Body mass index (BMI) was calculated using the formula Weight (kg) divided by height in meters squared, with BMI cut-offs corresponding to the ranges 18.5–25 kg.m-2 for Normal weight, 25– 30 kg.m-2 for overweight and BMI>30 kg.m-2 for obesity. Waist circumference (WC) and WC/H ratio (WHR) were determined to assess visceral fat or abdominal obesity. The WHO threshold values used are a WC>80 or WHR>0.85 cm for women and WC>94 or WHR>1 cm for men, indicating abdominal obesity, a WHR >0.85 makes it possible to determine whether an excessive amount of fat has accumulated around the internal organs for women and dividing the circumferences of WC and H, the ratio should not exceed 0.85 for women and 1 for men. [24].

2.5 Blood pressure measurements

After resting for 5 to 10 min, a measurement device was used to measure systolic blood pressure (SBP) and diastolic (DBP). Hypertension was defined by SBP > 140mmHg, and DBP> 90 mmHg.

2.6 Statistical analyzes

Statistics analyses are used to describe the population using SPSS version 23 software. A descriptive statistical analysis was performed and the t student test is used for comparisons of two means according to place of residence and sex. Comparisons of the prevalence of obesity classes (according to BMI, WC and WHR) were carried out using the $\chi 2$ test and the association of the different parameters by the Spearman correlations. Statistical significance was set at $P<0.05$.

3 Results

3.1 Prevalence of obesity

In the Table 1, the sociodemographic and anthropometric characteristics of the study sample are described for women (1.1) and men (1.2) from Khouribga province, according to the area of residence. The Table shows that the mean age, height, WHR, number of pregnancies, and nap duration are significantly different in women from both places of residence. However, all anthropometric measurements are comparable in men from both rural urban areas, while systolic (SBP) and diastolic (DBP) blood pressure are significantly higher in rural than in urban area.

3.2 Prevalence of obesity and hypertension according to socio-demographic criteria.

In Table 2 the prevalences of general and abdominal obesity based respectively on BMI, WC and WHR as well as hypertension are presented according to the area residency (urban and rural) and sex. The Table shows that 35.3% of the sample were normal weight (BMI between 18.5 and 25), 31.8% overweight (BMI between 25 and 30) and 33.1% were obese (BMI>30). The data showed also that abdominal obesity is highly prevalent in this population, representing 81.5% of the sample according to WC (WC>80 cm) and 77.2% according to WHR (WHR >0.85). The results reveal significantly higher prevalences of both types of obesity in women than men. The prevalence of hypertension was of 35.5% in this study sample and there was no difference between both sexes.

Table 1. Anthropometric characteristics of men and women from the Khouribga province by place of residence

1.1- Anthropometric Characteristics of Women				
	Mean ± SD (Min-Max)			p P-value
	Urban (n=155)	Rural (n=110)	Global (n=265)	Urban vs Rural
Age (yrs)	38.14 ± 13.17 (18-65)	41.51±12.28 (18-65)	39.54.13.12 (18-65)	0.039 *
Weight (kg)	79.96 ±18.17 (49-125)	76.90±18.22 (47-140)	78.6918.22 (47-140)	0.178 ns
Height (m)	1.63 ±0.05 (1.54-1.93)	1.62±0.05 (1.50-1.81)	1.630.05 (1.50-1.93)	0.043*
BMI (kg.m-2)	29.73 ± 6.20 (17.72-44.99)	29.10±6.56 (18.65-50.20)	29.476.35 (17.72-50.20)	0.428 ns
WC (cm)	103.48±18.72 (50-152)	105.52±19.70 (60-151)	104.33±19.14 (50-152)	0.395 ns
H (cm)	111.85±16.68 (70-159)	110.19±19.02 (62-154)	111.15±177.68 (62-159)	0.470 ns
WHR	0.92±0.14 (0.63-1.53)	0.97±0.15 (0.71-1.37)	0.94±0.15 (0.63-1.53)	0.032*
Pregnancies number	2.30±2.17 (0-10)	3.38±2.31 (0-10)	2.74±2.24 (0-10)	0.000***
Children number	2.02±1.89(0- 8)	2.82± 1.90(0-7)	2.341.93(0-8)	0.001***
Household size	3.31±2.07(1-15)	3.36±1.54(1-11)	3.331.87(1-15)	0.840 ns
Siesta (min)	33.46±31.09(0-1.20)	43.39±34.39(0-150))	32.78(0-150)	0.01**
DBP	12.65±1.77 (9-20)	13±1.93 (9.4-20.4)	12.8±1.84 (9-20.4)	0.128 ns
DBP	8.36±1.02 (6-12.5)	8.56±1.42 (5-14.9)	8.44±1.20 (5-14.9)	0.206 ns

1.2- Anthropometric Characteristics of Men				
	Mean ± SD (Min-Max)			Test t. P-value
	Urbain (n=87)	Rural (n=49)	Globale (n=136)	Urbain vs Rural
Age (yrs)	40.70 ± 13.45 (18-65)	46.20±14.43 (18-65)	42.6814.01 (18-65)	0.027 *
Weight (kg)	78.23 ±16.26 (50-141)	77.61±16.27 (49-127)	7816.20 (49-141)	0.830 ns
Height (m)	1.76 ±0.08 (1.53-1.92)	1.77±0.08 (1.53-1.94)	1.760.08 (1.53-1.94)	0.549 ns
BMI ($kg.m^{-2}$)	25.10 ± 4.33 (17.30-40.32)	24.70±4.74 (16.79-40.08)	24.954.47 (16.79-40.32)	0.615 ns
WC (cm)	103.61±19.71 (67-162)	104.20±17.06 (75-139)	103.82±18.75 (67-162)	0.870 ns
H (cm)	91.99±15.17 (59-148)	91.5±16.08 (66-134)	91.81±15.43 (59-148)	0.870 ns
WHR	1.13±0.16 (0.73-1.45)	1.15±0.13 (0.87-1.47)	1.13±0.15 (0.73-1.47)	0.497 ns
Household size	3.40±1.59 (1-7)	4.48±2.83 (1-11)	3.792.17 (1-11)	0.0006***
Siesta (min)	25.33±38.75 (0-180)	27.50±29.96 (0-120)	35.70 (0-180)	0.739 ns
SBP	12.98±1.54 (10-17)	14.06±1.87 (11.3-18)	13.37±1.74 (10-18)	0.000***
DBP	8.22±0.96 (6-10.3)	8.95±1.04 (7.4-11.5)	8.49±1.05 (6-11.5)	0.000***

BMI: Body mass Index, WC: Waist Circumference, H: Hip Circumference, WHR: WC/H (ratio of waist to hip circumference); SD: Standard Deviation, SBP: Systolic Blood pressure; DBP: Diastolic Blood pressure. * 0.05<P<0,01; ** 0.01<P<0,001; *** P<0,001, ns: Non significant difference

Table 2. Prevalence of obesity and hypertension in men and women from Khouribga province

	N	%	N	%	P-Value. testχ^2	N	%
Characteristics	Men		Women			Total	
General Obesity* BMI Categories	76	(55.9)	65	(24.6)		141	(35.3)
[Normal]	44	(32.4)	83	(31.4)	0.001***	127	(31.8)
[Overweight]	12	(8.8)	65	(24.6)		77	(19.3)
[Obesity]	4	(2.9)	51	(19.3)		55	(13.8)
>35	136	100	264	100			
Total						400	100
Abdominal obesity* WC							
[Normal]	39	(32.5)	32	(12.2)		71	(18.5)
[Moderate]	19	(15.8)	25	(9.5)	0.000***	44	(11 .5)
[Severe]	62	(51.5)	206	(78.3)		268	(70)
						383	100
Total	120	100	263	100			
WHR							
[Normal]	17	(14.3)	66	(26.9)		83	(22.8)
[Fat excess]	102	(85.7)	179	(73.1)	0.007**	281	(77.2)
Total	119		245			364	100
Blood Pressure							
Normotensives	79	(59,8)	177	(66,8)	0,173 NS	256	(64,5)
Hypertensives	53	(40,2)	88	(33,2)		141	(35,5)

Total	132		265			397	100

BMI: Body mass Index, 18,5-24,99[normal], 25-29,99[Overweight], >30 [Obesity], WC: Waist circumference; WC<80^{W} [Normal], <94^{M}, WC>80^{w} [moderate abdominal obesity: 94<WC<102 $^{M;}$ WC>88^{w} [Severe abdominal obesity]; WC>102, W: Women, M: Men; WHR: WC/H (ratio of waist to hip circumference), WHR<0,85^{W}, <1^{M} [Normal], WHR>0,85^{W}, >1^{M}, Blood Pressure: Hypertensive: SBP > 140mmHg, or DBP> 90 mmHg. * 0.05<P<0,01; ** 0.01<P<0,001; *** P<0,001, NS: Non significant difference.

Table 3 presents the prevalence of obesity and hypertension in men and women from urban and rural areas of residence. The table results show that the prevalence both general and abdominal obesity are not significantly different whatever the gender between the two areas of residence. The table shows also that hypertension was significantly higher in men (p value <0.002) residing in rural than in urban area. However, no significant difference was found between the two settings for women.

Table 3. Prevalence of obesity and hypertension among women and men from Khouribga province according to place of residence

	Women		Men	
	N (%)	N (%)	N (%)	N (%)
Characteristics	Urban	rural	urban	rural
Classe IMC				
18.5-24.99[normal]	38 (24.50)	27 (24.80)	48 (55.20)	28 (57.10)
25-29.99 [Overweight]	49 (31.6)	34 (31.2)	29 (33.3)	15 (30.60)
30-35 [Obesity]	35 (22 .6)	30 (27.50)	8 (9.2)	4 (8.20)
>35	33 (21.3)	18 (16.5)	2 (2.3)	2 (4.1)
Total	155	109	87(100)	49 (100)
χ^2 p-value (urbain-rural)	0.706 ns		0.925 ns	
Abdominal obesity* WC				
[Normal]	20 (12.9)	12 (10.90)	25 (32.1)	14 (33.3)
[Moderate].	16 (10.5)	9 (8.20)	14 (17.9)	5 (11.9)
[Severe]	117 (76.5)	89 (80.90)	39 (50)	23 (54.9)
Total	153 (100)	110 (100)	78 (100)	42 (100)
χ^2 p-value (urban-rural	0.705ns		0.756ns	
*WHR				
[Normal]	41 (28.9	25 (24.3)	13 (16.9)	4 (9.5)
[Fatexcess]	101 (71.1)	78 (75.7)	64 (83.1)	38 (90.5)
Total	142 (100)	103 (100)	77 (100)	42 (100)
χ^2 p-value (urban-rural	0.713ns		0.063ns	
Blod Pressure				
Normotensives	107 (69)	70 (63.6)	58 (6.9)	21 (42.9)
Hypertensives	48 (31)	40 (36.4)	25 (30.1)	28 (57.1)
Total	155 (100)	110 (100)	83 (100)	49 (100)
χ^2 p-value (urbain-rural)	0.358 ns		0.002**	

BMI: body mass index, 18,5-24,99[normal], 25-29,99[Overweight], >30 [Obesity], WC: Waist circumference, WC<80^{W} [Normal], <94^{M}. WC>80 ^{W}, 94<WC<102 ^{M} [moderate], WC>88 ^{W} [severe] TT>102 ^{M}WHR: WC/H (ratio of waist to hip circumference),

WHR<0,85^{W}, <1^{M} [Normal], WHR>0,85^{W}, >1^{M}, Blood Pressure: Hypertensive SBP > 140mmHg, or DBP> 90 mmHg., W: Women, M: Men. * 0.05<P<0,01; ** 0.01<P<0,001; *** P<0,001, NS: Non significant difference.

The prevalences of general and abdominal obesity estimated respectively by BMI, WC and WHR categories as well as the prevalence of hypertension according to age groups are presented in Table 4. In the global sample significant differences were found between age groups for BMI, WC, WHR and for blood pressure. Both obesity and hypertension increased with age. In women, the differences are highly significant for WC, WHR, and hypertension. The rates of abdominal obesity as expressed by WC, WHR were higher for the age group >50 years with respectively 84.8% (WC>88) and 90.8% (WHR>0.85). Similarly, the percentage of hypertensive individuals is high in the two age classes between 35-50 years (37.7%) and > 50 years (65.2%). In men, the differences are also highly significant for hypertension while these are not significant for WC. In the overall sample, the obesity rate expressed by WC is high (89.2%) in the 35-50 age group, with a lower prevalence in people of age over 50 years old (84.8). In the same way, the percentage of hypertensive individuals is increased with age, higher in the age group of >50 years (65.2%). In summary, both abdominal obesity and hypertension manifest themselves beyond the age of 35.

Table 4. Prevalence of obesity and hypertension in women and men in the Khouribga region according to age groups.

	Women			Men			Global		
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
	18-34.99	35-50	>50	18-34.99	35-50	>50	18-34.99	35-50	>50
BMI category [normal]	38(32.5)	19(22.9)	8 (12.50)	25(54.3)	20(50)	31(62)	63(38.7)	39 (31.7)	39(34.2)
[Overweight]	41 (35)	26(31.3)	16(25.00)	18(39.1)	12 (30)	14(28)	59(36.2)	38(30 .9)	30(26.3)
[Obesity] >35	16(13.7)	23(27.7)	26(40.60)	2 (4.3)	6 (15)	4 (8)	18(11)	29 (23.6)	30(26.3)
Total	22(18.8)	15(18.1)	14(21.90)	1 (2.2)	2 40	1 (2)	23(14.1)	17 (13.8)	15(13.2)
	117	83	64	46		50	114	123	114
χ^2 p-value	0 .043*			0.512 NS			0.043*		
WC [Normal]	24(20.9)	5 (6)	3 (4.7)	18(41.9)	8 (22.2)	13(31.7)	42(26.6)	13 (10.8)	16(15.2)
[moderate]	15(13)	9 (10.7)	1 (1.6)	7 (16.3)	7 (19.4)	5 (12.2)	22(13.9)	16 (13.4)	6 (5.8)
[severe]	76(66.1)	70(83.3)	60 (93.8)	18(41.9)	21(58.3)	23(56.1)	94(59.5)	91(75.8)	83 (79)
Total	115	84	64	43	36	41	158	120	105
χ^2 p-value	0.000***			0.378 NS			0.001**		
*WHR [Normal]	43(39.4)	18(22.8)	5 (8.8)	8 (18.6)	5 (14.3)	4 (9.8)	51(33.6)	23 (20.2)	9 (9.2)
[Fat excess]	66(60.6)	61(77.2)	52 (91.2)	35(81.4)	30(85.7)	37(90.2)	101(66.4)	91(79.8)	89(90.8)
Total	109	79	57	43	35	41	152	114	98
χ^2 p-value	0.000***			0.511NS			0.000***		
Blood Pressure Normotensives	100(85.)	50(59.5)	27(42.2)	41(89.1)	26(68.4)	12 (25)	141(86.5)	76 (62.3)	39(34.8)
Hypertensives	17(14.5)	34(40.5)	37(57.8)	5 (19.9)	12(31.6)	36 (75)	22 (13.5)	46 (37.7)	73(65.2)
Total	117	84	64	46	38	48	163	122	112
χ^2 p-value	0.000***			0.000***			0.000***		

BMI : body mass index 18,5-24,99[normal], 25-29,99[Overweight], >30 [Obesity], WC: Waist circumference, , WC<80^{W} [Normal], <94^{M}. WC>80 ^{W}, 94<WC<102 ^{M} [moderate], WC>88 ^{W} [severe] TT>102 ^{M} ,WHR: WC/H (ratio of waist to hip circumference), WHR<0,85^{W}, <1^{M} [Normal], WHR>0,85^{W}, >1^{M}, Blood Pressure : Normotensives : SBP > 140mmHg, and DBP> 90 mmHg., SBP : Systolic Blood pressure; DBP: Diastolic Blood pressure, W: Women, M: Men, SD : Standard Deviation , * 0.05<P<0,01 ; ** 0.01<P<0,001 ; *** P<0,001, ns: Non significant difference

3.3 Effects of sociodemographic parameters on obesity

Several sociodemographic variables were examined in relation to obesity (Table 5). The number of children per woman revealed significant associations according to weight, WC and BMI. Indeed, women with more than three children have increased weight, BMI and WC compared to women with less than three children or without children, indicating that obesity in the sample would be partly linked to reproductive life of women. On the other hand, the classes of monthly income, the number of people per family, the profession of the woman, the type of family, nuclear or composite, the level of education and the usual time of awakening do not show any significant association. (Results not shown).

Table 5. Distribution of anthropometric measurements among women in the Khouribga region according to the number of children

		Mean ± SD					
Number of children	N	Height (cm)	Weight (Kg)	WC (cm)	H (cm)	BMI (kg.m^{-2})	(WHR)
0(1)	17	1.63±0.05	69.55±17.89	96±20.22	102.95±14.39	26.09±6.79	0.93±0.14
0<Childre n<3 (2)	39	1.62±0.06	74.93±14.48	100.80±19.69	108.37±19.22	28.37±4.80	0.94±0.17
≥3 (3)	61	1.63±0.04	86.07±17.84	112.43±16.67	112.33±16.72	32.13±6.31	1.01±0.16
Total	117	1.63±0.05	79.96±17.94	106.16±19.30	109.65±17.47	30±6.33	0.98±0.16
	P-Value						
(1)vs(2)		1	0.820	1	0.850	0.570	1
(1)vs(3)		1	0.002	0.004	0.151	0.001	0.224
(2)vs(3)		0.534	0.005	0.007	0.800	0.007	0.095

BMI: Body mass index, WC: Waist Circumference, H: Hip Circumference, WHR: WC/H (ratio of waist to hip circumference). * 0.05<P<0,01; ** 0.01<P<0,001; *** P<0,001, ns: Non significant difference

3.4 Anthropometric characteristics and biochemical parameters associated with hypertension

Table 6 presents the comparisons of mean age, BMI and biochemical parameters (blood glucose or Glycemia (Gly), Triglycerides (TG), Total cholesterol (TChol) and Uric acid (UAc) in normotensives and hypertensives of both sexes. The table shows that in women, hypertension is associated with significantly high rates of anthropometric and biochemical measurements except TChol. Indeed, women with hypertension have higher age, BMI, blood glucose and TG than normotensive ones. In the hypertensive men, the results revealed significantly higher age and blood glucose levels. Hypertensive men have an average age of 51.45 years and an average Gly of 1.35 g/l, higher than their normotensive counterpart whose age and Gly are respectively 36.5 years and 1.01 g/I.

Table 6. Comparaison of age, BMI and biochemical parameters in both sexes with or without hypertension

	Women (W)		P-value	Men (M)			T-test W vs M
	Normal BP (66.80)	High BP (33.20)		Normal BP (59.80)	High BP (40.20)	T-test ns	
Age	35.98±12.32	46.70±11.72	0.000	36.50±12.62	51.45±11.20	0.000	0.01
BMI	28.15±5.95	32.12±6.33	0.000	25.29±4.59	24.45±4.37	ns	0.000
Gly	1.04±0.52	1 .29±0.62	0.002	1.01±0.33	1.35±0.51	0.000	ns
TG	1.18±1.58	1.57±1.04	0.001	1.23±0.52	1.44±1.07	ns	ns
TChol	1.70±0.47	1.78±0.46	ns	1.55±0.43	1.71±0.52	ns	ns
UAc	51.71±16.28	51.09±13.95	ns	53.63±12.83	58.84±15.08	ns	0.01

BMI: Body mass index; Gly: glycemia; TG: triglycerides; TChol: Total Cholesterol; UAc: Uric acid; BP: Blood pressure. * 0.05<P<0,01; ** 0.01<P<0,001; *** P<0,001, ns: Non significant difference.

In the Table 7, frequency of hypertensive women and men evaluated according to age, BMI, and WC, WHR revealed significant differences in both sexes according to age groups, with high prevalences in age categories beyond 35 years old. Concerning BMI classes, the frequency of hypertensive women was increased from a BMI>30 (characterizing obesity), with significant differences. Significant differences are found for hypertensive women with abdominal obesity starting with values WC>88 (severe abdominal obesity) representing (87.5%). Based on WHR, the prevalence of hypertensives was 82.7% for WHR>0.85, these differences are significant. For hypertensive men, the differences were also significant for age and WHR.

Table 7. Distribution of hypertensives according to age and obesity in both sexes from the Khouribga province

	Hypertensive Women (W)			Hypertensive Men (M)			χ^2. P-value (W vs M)
	n	%	χ^2. P-value	n	%	χ^2. P-value	
Age Categories (yrs)							
18-34 .99	17	(19.3)		5	(9.5)	0.000***	
35-50	34	(38.6)	0.000***	12	(22.6)		0.01*
>50	37	(42.1)		36	(67.9)		
Total	88	100		53	100		
BMI category							
[Normal]	13	(14.8)		31	(58.5)		
[Overweight]	16	(18.2)		17	(32.1)	0.853 ns	0.000***
[Obesity]	33	(37.5)	0.000***	4	(7 .5)		
>35	26	(29.5)		1	(1.9)		
Total	88	100		53	100		

WC [Normal] [Moderate] [Severe] Total	2 9 77 88	(2.3) (10.2) (87.5) 100	0.002**	15 8 25 48	(31.3) (16.7) (52.1) 100	0.912ns	0.173ns
*WHR [Normal] [Fat excess] Total	14 67 81	(17.3) (82.7) 100	0.017*	3 45 48	(6.3) (93.8) 100	0.03*	0.001**

BMI: Body mass index body mass index 18,5-24,99[normal], 25-29,99[Overweight], >30 [Obesity], WC: Waist Circumferencee, WHR: WC/H (ratio of waist to hip circumference). WC<80^{W} [Normal], <94^{M}. WC>80 ^{W}, 94<WC<102 ^{M} [moderate], WC>88 ^{W} [severe] TT>102 ^{M}, WHR<0,85^{W}, <1^{M} [Normal], WHR>0,85^{W}, >1^{M}, Blood Pressure: Normotensives: SBP > 140mmHg, and DBP> 90 mmHg., SBP: Systolic Blood pressure; DBP:Diastolic Blood pressure, W: Women, M: Men. * 0.05<P<0,01; ** 0.01<P<0,001; *** P<0,001, NS: Non significant difference

3.5 Sedentary lifestyle and obesity

The relationship between sedentary lifestyle and obesity was highlighted by comparing the different parameters according to the duration of less (<1 hour) or more than one hour (>1 hour) spent in front of the television (Table 8). The analysis showed that a duration of more than one hour is associated with increased BMI and WC, these differences are significant. In addition, physical activity assessed by a walking duration >30 minutes is significantly associated with reduced obesity (according to BMI). Similarly, naps lasting more than 30 minutes increase the WHR. These differences between the two classes < 30 minutes and > 30 minutes are significant.

Table 8. Association of physical inactivity with obesity in men and women from the Khouribga province.

	Men			Women		
	BMI kg/m^2	WC cm	WHR	BMI kg/m2	WC cm	WHR
TV. Screen <1H >1H	 23.97 25 .09	 100.10 104.07	 1.17 1.12	 26.32 30.29	 97.05 106.09	 0.94 0.95
P-value	ns	ns	ns	***	**	ns
Walking 0 <30 >30	 26.6 24.88 23.89	 110 .46 101.92 99.79	 1.16 1.14 1.11	 31.39 29.48 28.13	 107.70 104.26 102.02	 0.94 0.95 0.94
P-value	*	*	ns	**	ns	ns

Nap < 30 min >30min	23.82 25.24	101.42 105.67	1.14 1.12	29.55 30.26	99.90 105.50	0.82 0.94
P-value	ns	ns	ns	ns	ns	***

BMI: Body mass index. WC: Waist Circumference. H: Hip Circumference. WHR: WC/H. Comparisons are made using test-t and ANOVA one factor: * 0.05<P<0.01; ** 0.01<P<0.001; *** P<0.001. ns: Non significant different.

Using Spearman correlation coefficients between the variables obesity. Hypertension. Age and sedentary factors are shown in Table 9. In women. General obesity expressed by BMI decreases with walking duration while it increases with nap. TV/screen and age. On the other hand, Abdominal obesity (according to WC) increases with nap duration and with age. According to WHR. it increases only with age.

In men, as in the case of women. General obesity (BMI) decreases with walking and increases with time spent in front of TV/Screen.

In addition, In women. hypertension increases with general obesity. Abdominal (BMI. WHR) and with age. However, In men hypertension increases with WHR and age. Similarly, the duration of the nap increases with age and that of the TV/Screen is reduced.

Table 9. Correlations of obesity factors in women and men

Women									
	1-Stress cat.	2- BMIcat.	3- AO	4-WHR	5-Walking	6- Nap	7-TV-screen	8- HTA	9. Age
1-Stress cat.		-0.12 NS	-0.115 NS	-0.019 NS	0.054 NS	0.099 NS	-0.119 NS	-0.076 NS	0.018 NS
2- BMI cat.			0.581 0.000***	0.16 0.012*	-0.231 0.000***	0.196 0.02*	0 .286 0.000***	0.291 0.000***	0.206 0.001**
3- AO				0.345 0.000***	0.078 NS	0.16 0.012*	0.031 NS	0.174 0.005**	0.280 0.000***
4-WHR					0.009 NS	0 .061 NS	0.005 NS	0.153 0.017*	0.278 0.000***
5- Walking						0.07 NS	0.11 NS	-0.102 NS	-0.116 NS
6- Nap							0 .006 NS	0.135 0.034*	0.048 NS
7-TV-screen								0.015 NS	-0.069 NS
8- HTA									0.378 0.000***
9. Age									

Men									
	1-Stress cat.	2- BMI cat.	3- AO	4- WHR	5- Walking	6- Nap	7-TV screen	8- HTA	9. Age
1-Stress cat.									
2- BMI cat.	-0.019 NS								
3- AO	-0.027 NS	0.608 0.000 ***							
4-WHR	-0.03 NS	0.085 NS	0.228 0.000*						
5- Walking	0.133 NS	-0 .153 NS	0.048 NS	-0.092 NS					
6- Nap	0.110 NS	0.087 NS	0.059 NS	-0.036 NS	0.022 NS				
7-TV-screen	0.208 0.019*	0.010 NS	0.092 NS	0.12 NS	-0.154 NS	0.053 NS			
8- HTA	0.055 NS	0.011 NS	0.054 NS	0.171 0.001*	-0.221 0.012*	0.060 NS	0.11 NS		
9. Age	0.025 NS	0.118 NS	0.125 NS	0.212 0.000**	-0.115 NS	0.271 0.002**	-0.278 0.001**	0.554 0.000***	

cat: categories, AO: Abdominal obesity. BMI: body mass index, WHR: Waist to Hip ration, HTA: Hypertension. Sperman correlation: * 0.05<P<0.01; ** 0.01<P<0.001; *** P<0.001. ns: Non significant difference.

4 Discussion

The present study reports high rates of obesity and its associated cardiovascular risks in the population of Khouribga province. The data obtained are the first of their kind in this province which is part of the large Chaouia-Ouardigha region. Indeed. While overweight is comparable in both sexes. The general obesity (according to BMI) represents about 44% in women and 12% in men. In addition, Abdominal obesity is widespread in this population. Affecting more women (87.8%) than men (67.3%). The same differences were observed in other Moroccan. African and Middle Eastern populations [25]. This trend is however reversed in European Mediterranean countries [26]. Across Morocco. Obesity rates vary by region and are in continuous increase [14, 19, 27, 28, 29, 30, 31, 15, 32].

In North Africa and the Middle East. The World Bank in 2016 [26] reported prevalences of obesity among adults aged 18 and over ranging from around 34 % in Tunisia and Algeria to 39 % in Libya and 41.1% in Egypt. The prevalence found (43.94%) in the present study is considered the highest of the region. On the other hand, Obesity in the study women was comparable to that of the Middle Eastern countries namely in Jordan (43.1%). In the UAE (41%) and in Saudi Arabia (42.3%). Using a binomial logistic regression analysis did not show any association of obesity with income or age. While the risk of becoming obese is 2.2 and 2.8 times increased respectively by the duration of the nap (more than 30 minutes/day); OR= 2.286 (IC= [1.092-4.785]. P value= 0.028) and the number of children (more than 3 children/woman); OR= 2.832 (IC= [1.485-5.398]. P value= 0.002). On the other side.

Walking for more than 30 minutes a day is a protective against obesity (OR= 0.366 (IC= [0.165-0.813]. P value= 0.014). Moreover. The lower is the level of education of women. More they are obese. Indeed. Women with lower education level had a significantly higher BMI compared to those with university levels (p=0.000) with a negative correlation between both variables (Spearman correlation Coefficient= -0.241; p=0.000). Abdominal obesity (AO). A known cardiovascular and metabolic risk associated with insulin resistance. Was also assessed in this study. The data show that AO in its severe form (WC>88 and WHR>0.85) was highly prevalent in the present population (78.3% and 73.1% respectively). These results are comparable to those recorded in other provinces of Morocco such as the South [15]. The North [33], In the region of Marrakech [29] as well as in the province of El-Jadida in the center[34] [35]. The data reported here do not reveal any significant association between severe abdominal obesity and age. Monthly income or walking. However, A number of more than 3children/woman. (OR= 3.860 (IC= [1.117-13.340]. P value= 0.03) and a nap duration greater than 30 min per day (OR= 6.372 (IC= [2.217-18.318]. P value= 0.001) are factors increasing the risk of abdominal obesity in this population. In addition, the present study also reveals a significant correlation between physical inactivity and abdominal obesity. This corroborates with the results of previous studies also reporting an association of abdominal obesity with physical inactivity [16].

Obesity is reported to be linked to various physical. Metabolic. Psychological and cardiovascular complications [19, 35]. In the present study. Hypertension is found in 33.2% of the female population of Khouribga province. This rate is comparable to that reported nationally [21, 22] and in different regions including in the centre (El Jadida) [19]. In the East (Oujda) [17]. In Meknes [31]. In south (Laayoune) [20] and in northern Morocco [33]. Although high in this study. This prevalence remains lower than that reported in North African countries. Algeria (49.7%) [38]. Tunisia (42.7%) [10] and in Egypt (54.4%) [39]. This rate is however comparable to that of women in Italy (34%) [40] and higher than that found in Spain (15.1%) [41]. Also. Analysis of data from the present study revealed a significant association between general obesity (BMI) and age with hypertension (general obesity (BMI >30. OR= 1.812. (IC= [1.056-3.11]. P value=0.031). (Women's age 35 - 50 years; OR= 3.516. (IC= [1.83-6.533]. P value=0.000). However, no association of hypertension with the place of residence or with AO (expressed by WC or WHR). Was recorded.

Compared to women. Men had lower rates of both general obesity (BMI) and abdominal obesity. This result is comparable to the national average [36] as well as the prevalence found in northern and southern Morocco [20, 33] while it is higher than that of Marrakech [29] and lower than in the Souss region in southern Morocco [14].

In men. The severe abdominal obesity (WC>102 cm) was highly prevalent (67.3%). Exceeding that found in Marrakech (31.3%) [29]. In northern Morocco (18.8%) [33] And in Gabonese population in sub-Saharan Africa (9.6%) [26] However the prevalence reported in this study is the lowest of the North African countries. The Arab world and the Mediterranean. It is estimated as 19.1% in Tunisia and Algeria. 22.7% in Egypt. 25% in Libya. 20.9% in Syria. 23.4% in Iraq. 27.5% in the Emirates. 28.22% in Jordan and 30.8% in Saudi Arabia. The rates recorded in Europe are about 24% in Spain and Greece. About 20.3% in Portugal and Italy [26]. Unlike in women. In the study men. The logistic regression analysis did not reveal any significant association between the risk factors studied and general obesity (BMI>30). Probably due to the small size of the sample.

The evidence of a link between obesity and cardiovascular diseases including hypertension has already been demonstrated in the literature. This is reported to be continuously increasing worldwide and is associated with numerous alterations including hemodynamic. Endocrine and inflammatory problems [37]. In this study. The prevalence of hypertension was 40.2% among men in Khouribga province with a higher rate in rural areas

(57.1%) compared to urban areas (30.1%). Probably because of stress linked to the lower socioeconomic status in rural people. At the country level. This percentage is close to that obtained in northern Morocco (47.5%) [33] ut is higher than the national average (30.2%) [21, 22]. Nevertheless. The reported prevalence among men in the study province is lower than in the North African region with 59.6% in Tunisia and 51.3% in Algeria [10] [38]. Moreover. This prevalence is within the range of Mediterranean countries. Being comparable to Italy (37%) (according to

https://www.epicentro.iss.it/ben/2002/settembre02/2_en#:~:text=Overall%2C%2031%25%20of%20the%20Italian.in%20the%20South%20(34%25 - Recherche Google) and higher than that of Spain (22.5%) [42]. The binary logistic regression analysis also shows that age is associated with a multiplication of the risk of developing hypertension by 3.532 times for the class (35-50 years) (I.C [1.027-12.146] p=0.045) and of by 34.76 for the class >50 years old (I.C [9.825-122.951] p=0.000]).

One of the explanations for the alarming data reported in this work could be the different facets of a global transition that Morocco is experiencing. associated with economic and lifestyle changes. Indeed. the high prevalence of obesity obtained in the population of the province studied. may be related to socioeconomic and sociodemographic factors. urbanization. physical inactivity and diet. Thus. urbanization has increased in the study province from 55.3% in 1982 to 61.3% in 1994. then to 65.6% in 2004 and 69.7% in 2014[23]. This trend may explain the transition to a sedentary lifestyle in parallel with an economic improvement associated with an abundance and an increased but unbalanced food consumption rich in energy. simple sugars. saturated fat and salt and poor in nutrients. in parallel with globalization [34, 43]. Moreover. the increase in hypertension was already reported to be associated with high salt consumption. favored by the consumption of ready-to-eat and industrialized food products [43,44]. Besides. the alarming prevalence of hypertension found in this study is associated with obesity. Age and metabolic alterations. In this case high levels of blood sugar and triglyceridemia. In summary. The data reported in this study testify to an altered nutritional situation characterized by excess weight associated with cardiovascular risk requiring a change in behavior to reverse this trend.

5 Conclusion

This study reports for the first time data on obesity and associated cardiovascular and metabolic problems in the province of Khouribga. An alarming prevalence of obesity and hypertension in the Moroccan population of this province are found. More marked in women and with a higher rate of hypertension among those with obesity. The risk of hypertension is amplified in women with a BMI greater than 30 and an age greater than 35 years. In men. Hypertension is associated only with age. The data also show that obesity is negatively correlated with the level of physical activity (walking) and favored by a sedentary lifestyle (nap). This work draws attention to the negative effects of obesity on health and the need to put in place adequate policy measures to maintain a balanced weight and avoid associated comorbidities.

6 Free and informed consent

This survey obtained the approval of the regional directorate of the Moroccan Ministry of Health of Beni Mellal - Khenifra Region, under number: 1083. Participation in the survey was voluntary, subject to the free and informed consent of the selected sample. After receiving a detailed explanation of the process and conditions of the survey, respondents are informed that they were free to participate or to leave the survey at any time.

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