Scientific Research Publishing

World Journal of Cardiovascular Diseases, 2022, 12, 444-456
https://www.scirp.org/journal/wjcd
ISSN Online: 2164-5337
ISSN Print: 2164-5329

Determinants of Regional Obesity (Visceral and Subcutaneous Obesity) within Cardiovascular Risk Factors in the Cardiology Department of the University Clinics of Kinshasa

Fabien Kintoki Mbala[1,2], Junior Mabidi Mbangi[1], Aliocha Natuhoyila Nkodila[3], Jean-Robert Makulo Risassi[1,4], Pascal Bayauli[5], Eleuther Kintoki Vita[1,2], Benjamin Longo-Mbenza[1,2,6*], Raoul Gombet[7], Christian Kisoka Lusunsi[8]

[1]Faculty of Medicine, University of Kinshasa, Kinshasa, DR Congo
[2]Cardiology Unit, Department of Internal Medicine, University Clinics of Kinshasa, Kinshasa, DR Congo
[3]Department of Family Medicine and Primary Health Care, Protestant University in Congo, Kinshasa, DR Congo
[4]Nephrology Unit, Department of Internal Medicine, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, DR Congo
[5]Cardiometabolic Unit, Department of Internal Medicine, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, DR Congo
[6]Walter Sisulu University, Mthatha, South Africa
[7]Marien Ngouabi University, Brazzaville, Republic of Congo
[8]Department of Public Health, Lomo University of Research, Kinshasa, DR Congo
Email: fkintoki@gmail.com, mbangijunior@gmail.com, nkodilaaliocha@gmail.com, jrmakulo2016@gmail.com, bayaulipascal@gmail.com, ekintoki@gmail.com, *longombenza@gmail.com, raoulgombet@yahoo.fr, christiankisoka1@gmail.com

How to cite this paper: Mbala, F.K., Mbangi Jr., M., Nkodila, A.N., Risassi, J.-R.M., Bayauli, P., Vita, E.K., Longo-Mbenza, B., Gombet, R. and Lusunsi, C.K. (2022) Determinants of Regional Obesity (Visceral and Subcutaneous Obesity) within Cardiovascular Risk Factors in the Cardiology Department of the University Clinics of Kinshasa. *World Journal of Cardiovascular Diseases*, **12**, 444-456.
https://doi.org/10.4236/wjcd.2022.129046

Received: August 1, 2022
Accepted: September 18, 2022
Published: September 21, 2022

Abstract

Objective: This study aimed to determine searching for the determinants of regional obesity (visceral and subcutaneous obesity) within the cardiovascular risk factors (CVRF) in patients followed in cardiology at the University Clinics of Kinshasa (UCK) in the Democratic Republic of Congo (DRC). **Material and Methods**: Cross-sectional and analytical study had sought the determinants of regional obesity (visceral and subcutaneous obesity) by bio-impedance inside the CVRF during the period from July 1 to September 31, 2014. The multivariate analysis (logistic regression) has established the levels of association between regional obesity and CVRF. The statistical significance threshold was set at $p < 0.05$. **Results**: A total of 642 patients participated in the present study. The frequencies of visceral and subcutaneous obesity were respectively 45.5% (without significant distinction between the two sexes: Men 48% n = 92/188 vs. Women 44.1 n = 200/454; p = 0.148) and 60.7% with a predominance in women (36.2 n = 68/188 vs. 70.9% n = 322/454; $p < 0.001$). The CVRF found that alongside regional obesity was: advanced age, tobacco use, alcohol use, physical inactivity, high blood pressure (HBP), diabetes mellitus (DM)

and Chronic renal failure (CRF) in the respective proportions of 50.8%, 13.4%, 44.2%, 86.3%, 10.7%, 13.4% and 0.3%. The determinants of regional obesity were advanced age, smoking and obesity on body mass index (BMI) for visceral obesity; advanced age, female gender, alcohol intake and obesity on BMI and waist circumference (WC) as well as hypertriglyceridemia for subcutaneous obesity. **Conclusion**: This study showed a significant frequency of regional obesity with the following determinants: advanced age, female gender, smoking, alcohol, BMI/WC obesity and hypertriglyceridemia.

Keywords

Regional, Visceral, Subcutaneous Adipose Tissue, Bio-Impedance, Determinant, CVRF, DRC

1. Introduction

Obesity is now a real public health problem (HP) for both developed and developing countries. Obesity is epidemic worldwide affecting adults as well as children and adolescents [1]. More than half of the adult population would be overweight or obese in 2030 [2]. An increase in the prevalence of overweight and obesity has been observed in adults, this is also seen in adolescents in recent decades [3]. Progress is also confirmed by some work carried out in developing countries, particularly in Africa [4] [5] [6] [7]. In the Democratic Republic of Congo (DRC), the data is patchy [8] [9] [10] [11] [12]. Obesity, especially VAT, is a cardiovascular risk factor (CVRF). It is accompanied by metabolic complications including diabetes mellitus (DM) type 2, in a context of metabolic syndrome (MS) [13]. Cardiovascular risk assessment studies specify the role of visceral adiposity, however, its assessment is not common practice in our country, the Democratic Republic of Congo (DRC). Obesity is a complex chronic pathology both in terms of pathophysiology and management [14]. It is a heterogeneous disease on the phenotypic level which evolves in several phases (constitution, maintenance, aggravation) whose determinants are multiple. We cannot therefore speak of a single disease, but rather of various types of obesity and medical situations. The development of fat mass is under the influence of genetic factors which are expressed as a function of environmental and behavioral factors. Changes in diet and reduction in physical activity lead to an imbalance in the energy balance. There are also psychosocial and biological factors. It is most often associated with other CVRFs, in the context of (MS), hence the need for preventive measures to reduce cardiovascular risk. The objective of the present study is to research the frequency of regional obesity (by impedancemetry) as well as their determinants within the CVRF in patients followed in cardiology at the University Clinics of Kinshasa (UCK) in the DRC.

2. Material and Methods

This cross-sectional and analytical study took place over a period of 3 months

(from July 1 to September 31, 2014) in the Cardiology department of the UCK (DRC). Given the absence of a prevalence, and based on the general sampling formula Ni (minimum size) ≥ $(Za)^2$ xpx $(1 - p)/(W)^2$ where P = prevalence (=0, 50 due to lack of data, W = range (0.05), confidence level (1 − a), a = 0.05 for 95%, Za = 1.96, sample size was calculated at $3.84 \times 0.50 \times 0.50/(0.05)^2 = 384$. By adding 10% of non-respondents, the height was estimated at ≥422.

Sampling was convenient and involved all patients followed in cardiology who voluntarily agreed to participate in the study. The parameters of interest were: demographic parameters (age, sex), intoxication parameters (alcohol and tobacco intake), hemodynamic parameters (history of hypertension, blood pressure or BP), biochemical parameters (total cholesterol or CT, HDL-cholesterol, LDL-cholesterol, glycemia) and impedancemetric parameters *i.e.* percentage or % of visceral obesity, subcutaneous obesity and muscle mass (MM).

Alcoholism was defined as consumption of more than 20 grams of alcohol, *i.e.* 2 glasses per day for women and more than 30 grams, or 3 glasses for men. [15]. Blood pressure was measured using an OMRON brand device, the values considered were the averages of the last 2 measurements (after resting for 5 minutes). Thus HBP was defined by a BP ≥ 140/90 mmHg [16].

Body composition (Visceral and subcutaneous obesity, MM) was calculated using a KARADA SCAN OMRON brand device (special scale with body composition monitor for electrical impedance) whose principle is based on bio-impedance. The device sends an extremely weak current of 50 KHz and <500 MA into the human body, in order to determine the amount of fatty tissue taking into account weight, height, age and gender. The conditions for measuring the bio-impedance were: a rest of at least 2 hours without taking anything, the scale being placed on a hard and horizontal surface, the subject in a standing position [17].

SPSS version 21 software was used for data entry and statistical analyses. Results were expressed as mean ± SD or median, with extremes depending on whether the data distribution was Gaussian or not. The comparison of the groups was made using the chi-square or Student's t test depending on the case (proportions or means). Multivariate analysis (logistic regression) was used to find the determinants of regional obesity within the CVFR. The statistical significance threshold was set at $p < 0.05$. All patients who participated in the study signed the informed consent document.

3. Results

3.1. Frequency of Regional Obesity and General Patient Characteristics

Of a total of 642 patients who participated in the study, the frequency of visceral obesity was 45.5% with no significant difference (p = 0.148) between the two sexes (**Figure 1**).

Figure 2, on the other hand, shows a frequency of subcutaneous obesity of

60.7% with a predominance ($p < 0.001$) for the female sex (70.9% n = 322/454 vs. 36.2% n = 68/188).

Figure 3 shows a significant increase ($p < 0.001$) in the frequency of visceral obesity with increasing age and a decrease from advanced age (≥60 years).

Figure 4, on the other hand, shows a tendency for the regression of the frequency of subcutaneous obesity to see-saw with age ($p < 0.001$) but with a clear reduction from advanced age (≥60 years).

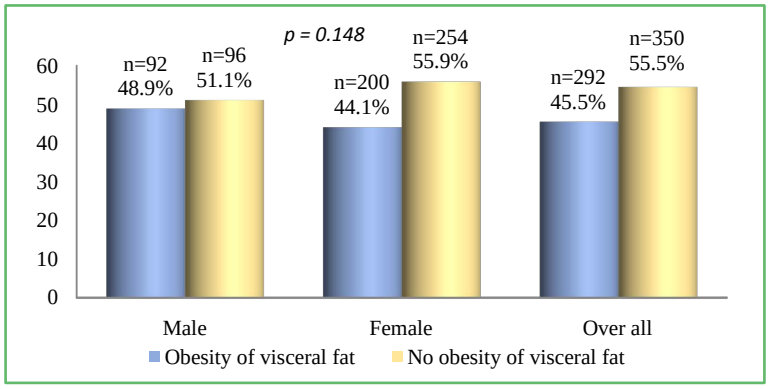

Figure 1. Frequency of visceral obesity in the entire group and in both sexes.

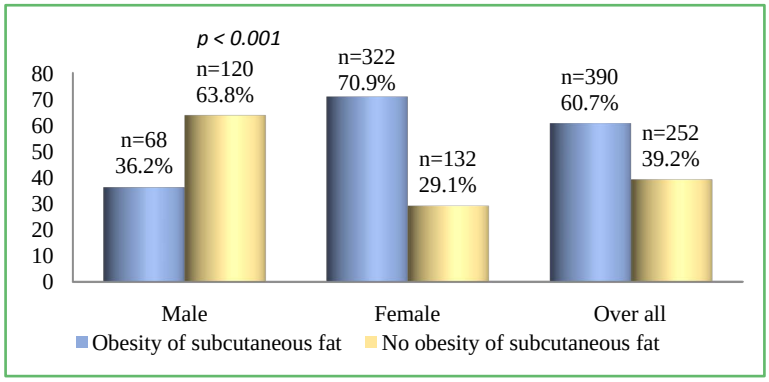

Figure 2. Frequency of subcutaneous obesity in the entire group and in both sexes.

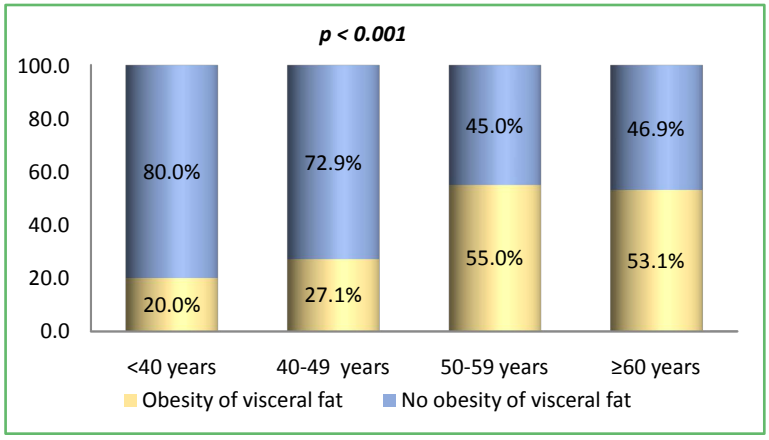

Figure 3. Frequency of visceral obesity according to age.

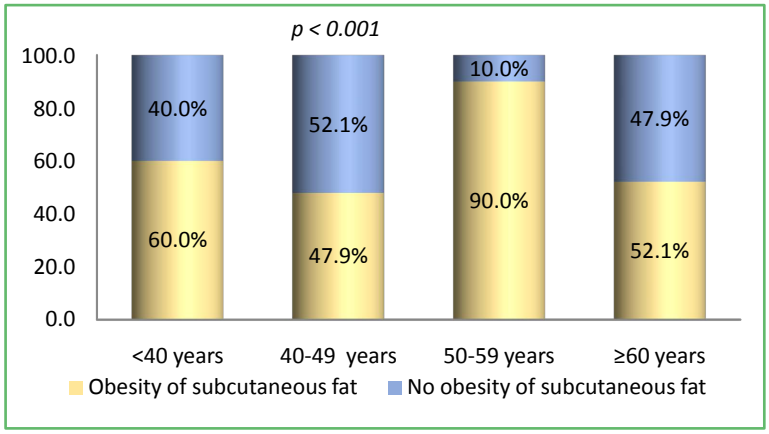

Figure 4. Frequency of subcutaneous obesity according to age.

3.2. Frequency of Other Cardiovascular Risk Factors

Table 1 shows the distribution of CVRF in the entire group and in both sexes. The mean age of the patients was 57.5 ± 14.4 years. The women were older than the men ($p = 0.002$). The frequency of HBP was 90.7% with predominance in women ($p = 0.015$). The frequency of the other CVRF is described in Table 1. In general, men were more affected ($p < 0.05$) by tobacco and alcohol intake, CRF and subclinical atherosclerosis (ATS) while women were more affected ($p < 0.05$) by physical inactivity, obesity on BMI and WC.

3.3. Cardiovascular Risk Factors and Regional Obesity

Table 2 shows the distribution of CVRF according to regional obesity. Patients with visceral obesity presented higher frequencies ($p < 0.05$) of advanced age, smoking, HBP, DM and obesity on BMI and WC. There was no difference between the two sexes ($p \geq 0.05$).

On the other hand, patients with subcutaneous obesity presented higher frequencies ($p < 0.05$) of tobacco use, alcohol use, physical inactivity, obesity/overweight on BMI and on WC, hypertriglyceridemia and ATS. The highest frequency of subcutaneous obesity concerned women (<0.001).

3.4. Determinants of Regional Obesity within CVRF

3.4.1. Visceral Obesity

Table 3 shows that in univariate analysis, age ≥ 60 years, smoking, HBP, DM, obesity/BMI and abdominal obesity/WC emerged as determinants of visceral obesity. After adjustment (multivariate analysis), advanced age, smoking, obesity on BMI had emerged as independent determinants of visceral obesity. Thus advanced age has multiplied the occurrence of visceral obesity by 2, smoking by 2, obesity on BMI by 4 and obesity on WC by 2.

3.4.2. Subcutaneous Adipose Tissue (SAT) Fat Mass

For subcutaneous obesity, age ≥ 60 years, female gender, alcohol intake, physical inactivity, obesity/BMI, overweight, abdominal obesity/WC, and hypertriglyce-

ridemia had emerged as determinants (univariate analysis). After adjustment (multivariate analysis), advanced age, female gender, alcohol intake, obesity/overweight on BMI, obesity on WC and hypertriglyceridemia were independently associated with the occurrence of subcutaneous obesity. Thus advanced age multiplied the occurrence of subcutaneous obesity by 4, alcohol intake by 0.3, obesity on BMI by 16, overweight on BMI by 11, obesity on WC by 4 and hypertriglyceridemia of 4 (Table 4).

Table 1. Distribution of cardiovascular risk factors in the entire group and in both sexes.

Variables	All n = 642	Male n = 118	Feminine n = 454	P
Age, mean ± SD	57.5 ± 14.4	59.5 ± 14.7	56.7 ± 14.2	0.002
<40 years, n (%)	80 (12.5)	18 (9.6)	62 (13.7)	
40 - 49 years, n (%)	96 (15.0)	34 (18.1)	62 (13.7)	
50 - 59 years, n (%)	140 (21.8)	26 (13.8)	114 (25.1)	
≥60 years, n (%)	326 (50.8)	110 (58.5)	216 (47.6)	
Smoking, n (%)	86 (13.4)	56 (29.8)	30 (6.6)	<0.001
Alcohol intake, n (%)	286 (44.2)	106 (56.4)	178 (39.2)	<0.001
Physical inactivity, n (%)	554 (86.3)	130 (69.1)	424 (93.4)	<0.001
HBP, n (%)	582 (90.7)	178 (94.7)	404 (89.0)	0.015
DM, n (%)	86 (13.4)	30 (16.0)	56 (12.3)	0.136
CRF, n (%)	2 (0.3)	2 (1.1)	0 (0.0)	0.085
Obesity/BMI, n (%)	192 (29.9)	26 (13.8)	166 (36.6)	<0.001
Overweight/BMI, n (%)	224 (34.9)	66 (35.1)	158 (34.8)	0.505
Obesity/WC, n (%)	410 (63.9)	66 (35.1)	344 (75.8)	<0.001
Hypercholesterolemia	50 (11.8)	16 (12.1)	34 (11.7)	0.512
HDL-c low, n (%)	64 (15.2)	20 (15.2)	69 (15.2)	0.561
High HDL-c, n (%)	40 (9.5)	16 (12.1)	24 (8.3)	0.142
Elevated TG, n (%)	48 (11.4)	12 (9.1)	36 (12.4)	0.204
ATS (high PP), n (%)	290 (45.2)	96 (51.1)	194 (42.7)	0.033

Abbreviations: HBP = High blood pressure, DM = Diabetes mellitus, CRF = Chronic renal failure, BMI = body mass index, WC = waist circumference, PP = pulse pressure, ATS = sub-clinical atherosclerosis.

Table 2. Cardiovascular risk factors and regional obesity.

Variables	Visceral obesity			Subcutaneous obesity		
	No Obesity	Obesity	P	No Obesity	Obesity	p
Advanced age (≥60 years old)	153 (43.7)	173 (59.2)	**<0.001**	156 (61.9)	170 (43.6)	**<0.001**
Sex			0.148			**<0.001**
Male	96 (27.4)	92 (31.5)		120 (47.6)	68 (17.4)	
Feminine	254 (72.6)	200 (68.5)		132 (52.4)	322 (82.6)	

Continued

Tobacco intake	38 (10.9)	48 (16.4)	**0.026**	42 (16.7)	44 (11.3)	**0.034**
Alcohol intake	162 (46.3)	122 (41.8)	0.144	142 (56.3)	142 (36.4)	**<0.001**
Physical inactivity	296 (84.6)	258 (88.4)	0.101	200 (79.4)	354 (90.8)	**<0.001**
HBP	308 (88.0)	274 (93.8)	**0.008**	232 (92.1)	350 (89.7)	0.199
DS	36 (10.3)	50 (17.1)	**0.008**	30 (11.9)	56 (14.4)	0.221
Obesity/BMI	58 (16.6)	134 (45.9)	**<0.001**	18 (7.1)	174 (44.6)	**<0.001**
Overweight/BMI	113 (32.3)	111 (38.0)	0.076	50 (19.8)	174 (44.6)	**<0.001**
Abdominal obesity/WC	185 (52.9)	225 (77.1)	**<0.001**	72 (28.6)	338 (86.7)	**<0.001**
Hypercholesterolemia	24 (10.3)	26 (13.7)	0.183	18 (9.2)	32 (14.2)	0.076
Low HDL-c	36 (15.5)	28 (14.7)	0.467	30 (15.3)	34 (15.0)	0.524
high HDL-c	20 (8.6)	20 (10.5)	0.308	14 (7.1)	26 (11.5)	0.086
Hypertriglyceridaemia	25 (10.8)	23 (12.1)	0.391	14 (7.1)	34 (15.0)	**0.008**
WC	150 (42.9)	140 (47.9)	0.113	136 (54.0)	154 (39.5)	**<0.006**

Abbreviations: HBP = High Blood Pressure, DM = Diabetes mellitus, CRF = Chronic renal failure, BMI = body mass index, WC = waist circumference, PP = pulse pressure, ATS = sub-clinical atherosclerosis.

Table 3. Factors associated with visceral obesity within CVRF.

Variables	Univariate analysis		Multivariate analysis	
	P	OR (95% CI)	P	ORa (95% CI)
Age ≥ 60 years old				
Nope		1		1
Yes	**<0.001**	1.87 (1.37 - 2.56)	**<0.001**	2.29 (1.60 - 3.26)
Tobacco				
Nope		1		1
Yes	0.040	1.62 (1.02 - 2.55)	**0.024**	1.78 (1.08 - 2.93)
HBP				
Nope		1		1
Yes	0.013	2.08 (1.17 - 3.69)	0.232	1.48 (0.78 - 2.81)
DS				
Nope		1		1
Yes	0.012	1.80 (1.14 - 2.86)	0.133	1.46 (0.89 - 2.40)
Obesity/BMI				
Nope		1		1
Yes	**<0.001**	4.27 (2.97 - 6.14)	**<0.001**	3.73 (2.45 - 5.68)
Abdominal obesity/WC				
Nope		1		1
Yes	**<0.001**	3.00 (2.12 - 4.23)	**0.002**	1.91 (1.28 - 2.86)

Table 4. Factors associated with subcutaneous obesity within CVRF.

Variables	Univariate analysis		Multivariate analysis	
	P	OR (95% CI)	P	ORa (95% CI)
Age ≥ 60 years old				
Nope		1		1
Yes	**<0.001**	2.10 (1.52 - 2.91)	**<0.001**	3.70 (2.08 - 6.59)
Sex				
Male		1		1
Feminine	**<0.001**	4.31 (3.00 - 6.17)	**0.024**	2.00 (1.10 - 3.66)
Alcohol				
Nope		1		1
Yes	**<0.001**	0.44 (0.32 - 0.61)	**<0.001**	0.25 (0.14 - 0.45)
Physical inactivity				
Nope		1		1
Yes	**<0.001**	2.56 (1.62 - 4.05)	0.330	1.60 (0.62 - 4.09)
Obesity/BMI				
Nope		1		1
Yes	**<0.001**	10.47 (6.23 - 17.60)	**<0.001**	15.59 (6.67 - 36.41)
Overweight/BMI				
Nope		1		1
Yes	**<0.001**	3.25 (2.25 - 4.70)	**<0.001**	10.46 (5.04 - 21.70)
Abdominal obesity/WC				
Nope		1		1
Yes	**<0.001**	16.25 (10.89 - 24.24)	**<0.001**	3.54 (1.82 - 6.87)
Hypertriglyceridaemia				
Nope		1		1
Yes	**0.013**	2.30 (1.20 - 4.43)	**0.008**	3.54 (1.39 - 9.04)

4. Discussion

The main results of the present study are as follows: regional obesity (visceral and subcutaneous obesity) was frequent in current practice without gender distinction for visceral obesity but with a female predominance for subcutaneous obesity. Advanced age, tobacco use, alcohol use, physical inactivity, hypertension, DM and CRF were the CVRF found alongside regional obesity. Among these CVRF, the determinants of regional obesity were advanced age, smoking and obesity on BMI for visceral obesity; advanced age, female gender, alcohol intake and obesity on BMI and WC as well as hypertriglyceridemia for subcutaneous obesity.

4.1. Prevalence of Regional Obesity

The present study found frequencies of visceral and subcutaneous obesity of 45.5% and 60.9% respectively. BMI is an indicator usually used in the evaluation of obesity and a guide for population monitoring of weight, but it is an imperfect indicator in the study of the regional distribution of obesity. [18] [19] [20] [21]. It does not provide any information on the distribution of adiposity in individuals. The prevalences of obesity on high BMIs therefore relate only to global and not regional obesity [22] [23]. These prevalences reach 39.6% in adults and 18.5% in children. Thus, additional anthropometric measurements such as the WC prove useful in order to identify individuals characterized by an accumulation of abdominal fat that is especially harmful to health. Indeed, several large-scale epidemiological studies have shown that waist circumference is more closely associated than BMI with the risk of developing chronic diseases such as type 2 diabetes and cardiovascular disease [24] [25].

Obesity, once considered the preserve of industrialized countries, has now become a global epidemic [26]. The frequency of obesity continues to grow. In industrialized countries, the frequency of obesity has increased by between 5% and 10% over the past ten years [27] [28]. An increase in the frequency of obesity is also confirmed by some studies carried out in African countries [29] [30] [31] [32].

4.2. Cardiovascular Risk Factors and Determinants of Regional Obesity

The study of obesity and other cardiovascular risk factors is of great interest in both Difference Between developed Countries and developing Countries. Indeed, studies had shown the constant progression of obesity since the 1990 [33] [34]. Obesity is a chronic disease with multiple etiologies, including genetics, environment, lifestyle and diet. Numerous epidemiological studies have shown the role of obesity as an independent risk factor for CVD [35]. It is also a risk factor for other diseases which are themselves CVRF, namely: DM, dyslipidemia and HBP [36].

Several CVRF may be associated with the onset of obesity. Regarding regional obesity in our study: advanced age (≥60 years), smoking, obesity by BMI were independently associated with the occurrence of visceral obesity while advanced age, female sex, alcohol intake, high BMI (overweight and obesity) were for SAT fat mass. The presence of these risk factors in the obese subject should prompt a search for metabolic syndrome, a major risk factor for CVD.

With age, body composition changes. Lean mass becomes scarce and fat mass tends to accumulate at the visceral level due to the reduction in the level of physical activity. The fact that women are affected in regional (Subcutaneous) obesity gives a picture of the higher level of physical activity in men compared to women.

The impact of smoking on obesity is twofold. Classically, smokers are charac-

terized by weight loss and adiposity due to a reduction in appetite on the one hand (reduction in calorie intake) and on the other hand because nicotine increases energy expenditure at rest by its sympathomimetic effect [37] [38]. This corresponds on average to an increase of 200 kcal in energy expenditure for 25 cigarettes smoked per day, which would amount to a loss of around 10 kg over one year if calorie intake remained unchanged.

However, "heavy" smokers (*i.e.* smokers who smoke more than 25 cigarettes a day) weigh more than smokers who smoke less [39]. The hypotheses which try to explain this paradoxical phenomenon are the following: first of all, smokers tend to be more sedentary, to eat less healthily and to consume more alcohol compared [40]. In this situation, the harmful effects of physical inactivity and an unhealthy diet outweigh the antagonizing effect of cigarette-related weight gain.

Although BMI is the most frequently used tool for documenting the risks associated with excess weight and for measuring changes in the prevalence of obesity at the population level, the addition of WC makes it possible to appreciate the regional distribution of obesity. Several studies including ours have shown an increase in abdominal obesity within BMI categories. Thus, it is also important to follow the evolution of abdominal obesity and WC in the population. The impedancemetry used in the present study made it possible to study the regional distribution of adiposity.

5. Conclusion

A significant frequency of regional obesity (visceral and subcutaneous obesity) has just been found as determinant among the other cardiovascular risk factors: advanced age, tobacco, obesity on BMI for visceral obesity, and advanced age, alcohol, overweight and obesity on BMI for subcutaneous obesity.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Nguyen, T. and Lau, D.C. (2012) The Obesity Epidemic and Its Impact on Hypertension. *Canadian Journal of Cardiology*, **28**, 326-333. https://doi.org/10.1016/j.cjca.2012.01.001

[2] Kelly, T., Yang, W., Chen, C.S., Reynolds, K. and He, J. (2008) Global Burden of Obesity in 2005 and Projections to 2030. *International Journal of Obesity*, **32**, 1431-1437. https://doi.org/10.1038/ijo.2008.102

[3] De Onis, M. and Lobstein, T. (2010) Defining Obesity Risk Status in the General Childhood Population: Which Cut-Offs Should We Use? *International Journal of Pediatric Obesity*, **5**, 458-460. https://doi.org/10.3109/17477161003615583

[4] Abdullah, A., Peeters, A., de Courten, M., *et al.* (2010) The Magnitude of Association between Overweight and Obesity and the Risk of Diabetes: A Meta-Analysis of Prospective Cohort Studies. *Diabetes Research and Clinical Practice*, **89**, 309-319.

https://doi.org/10.1016/j.diabres.2010.04.012

[5] NCD Risk Factor Collaboration (NCD-RisC) (2017) Worldwide Trends in Body-Mass Index, Underweight, Overweight, and Obesity from 1975 to 2016: A Pooled Analysis of 2416 Population-Based Measurement Studies in 128.9 Million Children, Adolescents, and Adults. *The Lancet*, **390**, 2627-2642.

[6] (2009) Obesity in Canada—Snapshot. Public Health Agency of Canada, Ottawa. https://www.canada.ca/en/public-health/services/reports-publications/obesity-canada-snapshot.html

[7] (2011) Obesity in Canada—Health and Economic Implications. Public Health Agency of Canada, Ottawa. https://www.canada.ca/en/public-health/services/health-promotion/healthy-living/obesity-canada/health-economic-implications.html

[8] Sumaili, E.K., Krzesinskib, J.-M., Cohenc, E.P. and Nseka, N.M. (2010) Epidemiology of Chronic Kidney Disease in the Democratic Republic of Congo: A Synthetic Review of Studies from Kinshasa, the Capital. *Nephrology and Therapeutics*, **6**, 232-239.

[9] Kasiam, J.B., Longo-Mbenza, B., NgeOkwe, A. and Kangola Kabangu, N. (2007) Survey of Abdominal Obesity in an Adult Urban Population of Kinshasa, Democratic Republic of Congo. *Cardiovascular Journal of Africa*, **18**, 300-307.

[10] Bukabau, J.B., Makulo, J.R.R., Pakasa, N., Cohen, E.P., Lepira, F.B., Kayembe, P.K., *et al.* (2012) Chronic Kidney Disease among High School Students of Kinshasa. *BMC Nephrology*, **13**, Article No. 24. https://doi.org/10.1186/1471-2369-13-24

[11] Katchunga, B.P., M'buyamba Kayamba, J.R., Masumbuko, B.E., Kashongwe, M.Z., Degaute, J.P., Kabinda, J.F. and M'buyamba Kabangu, J.R. (2011) Arterial Hypertension in Congolese Adults from South Kivu: Results of the Vitaraa Study. *La Presse Médicale*, **40**, 315-323. https://doi.org/10.1016/j.lpm.2010.10.036

[12] Kintoki, M., Lufiauluisu, G., Lépira, B., Makulo, R. and Longo, L. (2015) Frequency and Determinants of Visceral and Subcutaneous Obesity in a Student Environment at the University of Kinshasa, Democratic Republic of the Congo. *Innov. res. health sci. biotechnol.*, **1**, 56-62.

[13] Murray, C.J. and Lopez, A.D. (1997) Mortality by Cause for Eight Regions of the World: Slovenian Burden of Disease Study. *The Lancet*, **3**, 1269-1276. https://doi.org/10.1016/S0140-6736(96)07493-4

[14] Faucher, P. and Patou, C. (2016) Pathophysiology of Obesity. *Revue du Rheumatism Monographs*, **83**, 6-12. https://doi.org/10.1016/j.monrhu.2015.08.002

[15] WHO (2006) The WHO STEPwise Approach to Chronic Disease Risk Factor Surveillance.

[16] Remmillard, G., Dupont, M.C., Langlois, E., *et al.* (2006) Understanding and Overcoming Obesity: The Urgency to Act. National Library of Quebec, Quebec.

[17] Coutinho, T., Goel, K., Correa de Sá, D., *et al.* (2011) Central Obesity and Survival in Subjects with Coronary Artery Disease: A Systematic Review of the Literature and Collaborative Analysis with Individual Subject Data. *Journal of the American College of Cardiology*, **57**, 1877-1886. https://doi.org/10.1016/j.jacc.2010.11.058

[18] Czernichow, S., Kengne, A.P., Stamatakis, E., *et al.* (2011) Body Mass Index, Waist Circumference and Waist-Hip Ratio: Which Is the Best Discriminator of Cardiovascular Disease Mortality Risk? Evidence from an Individual-Participant Meta-Analysis of 82,864 Participants from Nine Cohort Studies. *Obesity Reviews*, **12**, 680-687. https://doi.org/10.1111/j.1467-789X.2011.00879.x

[19] Lee, C.M., Huxley, R.R., Wildman, R. and Woodward, M. (2008) Indices of Abdominal Obesity Are Better Discriminators of Cardiovascular Risk Factors than BMI: A Meta-Analysis. *Journal of Clinical Epidemiology*, **61**, 646-653. https://doi.org/10.1016/j.jclinepi.2007.08.012

[20] Yusuf, S., Hawken, S., Ounpuu, S., *et al.* (2005) Obesity and the Risk of Myocardial Infarction in 27,000 Participants from 52 Countries: A Case-Control Study. *The Lancet*, **366**, 1640-1649. https://doi.org/10.1016/S0140-6736(05)67663-5

[21] Arsenault, B.J., Beaumont, E.P., Després, J.P. and Larose, E. (2012) Mapping Body Fat Distribution: A Key Step towards the Identification of the Vulnerable Patient? *Annals of Medicine*, **44**, 758-772. https://doi.org/10.3109/07853890.2011.605387

[22] Canoy, D., Boekholdt, S.M., Wareham, N., Luben, R., Welch, A., Bingham, S., Buchan, I., Day, N. and Khaw, K.T. (2007) Body Fat Distribution and Risk of Coronary Heart Disease in Men and Women in the European Prospective Investigation into Cancer and Nutrition in Norfolk Cohort: A Population-Based Prospective Study. *Circulation*, **116**, 2933-2943. https://doi.org/10.1161/CIRCULATIONAHA.106.673756

[23] Ohlson, L.O., Larsson, B., Svardsudd, K., Welin, L., Eriksson, H., Wilhelmsen, L., Bjorntorp, P. and Tibblin, G. (1985) The Influence of Body Fat Distribution on the Incidence of Diabetes Mellitus. 13.5 Years of Follow-Up of the Participants in the Study of Men Born in 1913. *Diabetes*, **34**, 1055-1058. https://doi.org/10.2337/diab.34.10.1055

[24] Lassale, C., Tzoulaki, I., Moons, K., Sweeting, M., Boer, J., *et al.* (2018) Separate and Combined Associations of Obesity and Metabolic Health with Coronary Heart Disease: A Pan-European Case-Cohort Analysis. *European Heart Journal*, **39**, 397. https://doi.org/10.1093/eurheartj/ehx448

[25] WHO Expert Committee (1995) Physical Status: The Use and Interpretation of Anthropometry. WHO Technical Report Series No. 854, WHO, Geneva, 452.

[26] Raccah, D. (2000) Obesity: Epidemiology, Diagnosis and Complications. *Endocrinology*, *Metabolism and Nutrition*, **50**, 549-552.

[27] Chobanian, A.V., Bakris, G.L., Black, H.R., Cushman, W.C., *et al.* (2003) The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: The JNC 7 Report. *JAMA*, **289**, 2560-2572. https://doi.org/10.1001/jama.289.19.2560

[28] Ba, M.L. (2000) Obesity in Mauritania: Epidemiologic Aspects. *Tunisie Medicale*, **78**, 671-676.

[29] Zabsonré, P., Sedogo, B., Lankoande, D., Dyemkouma, F.X. and Bertrand, Ed. (2000) Obesity and Chronic Diseases in Sub-Saharan Africa. *Medecine d'Afrique Noire*, **47**, 5-9.

[30] Etoundi, N.L.S., Longo, F., Melaman, S.F., Temgoua, T.S. and Bopelet, M. (2001) Obesity, Arterial Hypertension and Diabetes in a Population of Rural Women in Western Cameroon. *Medecine d'Afrique Noire*, **40**, 391-393.

[31] Monabeka, H.G., Bouenizabila, E., Kibeke, P. and Nsakala-Kibangou, N. (2007) Obesity and Type 2 Diabetes in Congolese Urban Areas. *Annales de L'universite Marien Ngouabi*, **8**, 38-42.

[32] Ziegler, O. and Derby, O. (1998) Epidemiology of Adult Obesity. Encyclopédie Médico-Chirurgicale (Elsevier, Paris), Endocrinology-Nutrition. 10-506-B-20:7.

[33] Must, A., Jacques, P.F., Dallal, G.E., Bajema, C.J. and Dietz, W.H. (1992) Long-Term Morbidity and Mortality of Overweight Adolescents. A Follow-Up of the Harvard Growth Study of 1922 to 1935. *The New England Journal of Medicine*,

327, 1350-1355. https://doi.org/10.1056/NEJM199211053271904

[34] Gross, P., Werhya, G., Seng, G., Debry, G. and Drouin, P. (1989) Obesity. Epidemiology and Risks of Obesity. *Revue du Praticien*, **39**, 2355-2360.

[35] Colin, I.M. (2005) Obesity Metabolic Syndrome and Diabetes: The Designated Accomplices of a New Kind of Epidemic. *Leuven Med.*, **124**, 6-10.

[36] Audrain-McGovern, J. and Benowitz, N.L. (2011) Cigarette Smoking, Nicotine, and Body Weight. *Clinical Pharmacology & Therapeutics*, **90**, 164-168. https://doi.org/10.1038/clpt.2011.105

[37] Hofstetter, A., Schutz, Y., Jequier, E., *et al.* (1986) Increased 24-Hour Energy Expenditure in Cigarette Smokers. *The New England Journal of Medicine*, **314**, 79-82. https://doi.org/10.1056/NEJM198601093140204

[38] Chiolero, A., Jacot-Sadowski, I., Faeh, D., *et al.* (2007) Association of Cigarettes Smoked Daily with Obesity in a General Adult Population. *Obesity* (*Silver Spring*), **15**, 1311-1318. https://doi.org/10.1038/oby.2007.153

[39] Chiolero, A., Wietlisbach, V., Ruffieux, C., *et al.* (2006) Clustering of Risk Behaviors with Cigarette Consumption: A Population-Based Survey. *Preventive Medicine*, **42**, 348-353. https://doi.org/10.1016/j.ypmed.2006.01.011

[40] Shields, M., Tremblay, M.S., Connor Gorber, S. and Janssen, I. (2012) Measures of Abdominal Obesity within Body Mass Index Categories, 1981 and 2007-2009. *Health Reports*, **23**, 33.