EFFECT OF OBESITY ON THE HEMOGRAM PROFILE IN PEOPLE ATTENDING THE REGIONAL HOSPITAL BAFOUSSAM, CAMEROON

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Abstract-
Background: Obesity is a major public health problem and the most common nutritional disease in industrialized and developing countries. It is an important risk factor for chronic diseases as well as disorders including: cardiovascular diseases, type 2 diabetes, cancers in general, and effects on blood profile especially anemia. The aim of this study was to effect of obesity on the hemogram profile in people attending the Regional Hospital Bafoussam, Cameroon
Methods: This study was done at the Regional Hospital Bafoussam, on 215 purposively sampled consented study participants. Height, weight, body mass index, blood pressure, blood analysis were done using standardized methods. Statistical analysis was done using the Statistical package for social sciences (SPSS version 21). The Chi square test and the analysis of variance test (ANOVA) were used to compute inferential statistics. A p value < 0.05 was considered statistically significant.
Results: Out of 215 study participants obtained in total, the prevalence of obesity was 32.1% (n=69). Factors that were significantly associated with obesity were female gender (p=0.004), age (p=0.002) and marital status (p=0.0001). The variations observed on the blood count profile were: the appearance of false polycythemia (in morbid obesity), the decrease in the average values of white blood cells (WBC), red blood cells (RBC), hemoglobin (HB), hematocrit (HCT), mean cell volume (MCV) and mean cell hemoglobin concentration (MCHC) in obese people. There was also an observed increase in mean platelet (PLT). Obesity had a statistically significant effect on RBC (p=0.04), HGB (p=0.044) and HCT (p=0.027); indeed, the more the weight increases, the more the RBC, HB and HCT decrease.
Conclusion: This study concludes that obesity has a significant effect on blood count parameters, in particular red blood cells, hematocrit and hemoglobin. It is very important to control for the effects of obesity on RBC, HB and HCT in obesity management.

Keywords: **Hemogram, obesity, Bafoussam Regional Hospital.**

Introduction

In healthy young adults, body fat distribution is 10-15% of total body weight in men and 20-25% in women [1]. In practice, the weight status is defined from the body mass index (BMI) which is the ratio of the weight (in kg) over the square of height (in meters) [1]. In adults (from 18years and above), obesity is defined by a BMI $\geq$ 30 kg/m^2, associated with an increased risk of comorbidity and mortality. The thresholds are the same for men and women [2].
For a decade, obesity has been recognized as an independent and predisposing factor to other risk factors (insulin resistance, hyperglycaemia, hypertriglyceridemia, and hypertension) implicated in the development of various cardiometabolic complications (pre-diabetes, metabolic syndrome), leading to the risk of type 2 diabetes, cardiovascular diseases, and premature death [3]. These deleterious consequences not only reduce the quality of life and autonomy of the person, but they also create a burden on the socio-economic system [4]. It has been proven that blood pressure increases with weight and hypertension becomes three times more common in obese subjects than in the normal population [4]. The risk of arterial thromboembolic diseases is also increased; atheroma (i.e. deposits of fatty plaques in the lumen of the arteries) of the coronary arteries which causes angina pectoris (or angina), and a risk of myocardial infarction [5]. There has also been increased risks of phlebitis (doubled in obese over 100 kg), the most serious consequence of which is pulmonary embolism. The frequency of diabetes and hypercholesterolemia in the obesity also increases [5]. In obesity, the increase in circulating fat considerably increases vascular and cardiac risk. This risk is five times higher in the obese patients compared to that of the normal population. The most common disorder is elevated blood triglycerides and LDL cholesterol [5].

Studies on normal weight women and class 1 overweight or obese women have shown that obesity is associated with a decrease in heme iron intake as well as an increase in non-heme iron intake, leading to an alteration in hemoglobin concentration and red blood cell count [4,6]. Although the relationship between variations in body weight, the lipid profile and the profile of the hemogram of individuals is increasingly clarified in the literature, the number of studies highlighting this relationship remains lower, particularly in Cameroon. The present work therefore has the general objective to determine the effect of obesity on the blood profile in obese and non-obese people attending the Regional Hospital Bafoussam.

Methods

This study utilized an institutional cross sectional study design from the 12th of April to 12th of July 2021 at the Regional Hospital Bafoussam. It involved 215 purposively sampled consented study participants. Weight was measured using the ACUPREG Scale while blood pressure was measured using the automatic blood pressure machine (ANDON INFLATABLE). Height was measured in standing position using a tape meter (graduated in millimeters) with the shoulders in a normal position. Body mass index (BMI) was defined as weight in kilograms divided by height in meters squared. Overweight was defined as BMI 25.0–29.9 kg/m^2 and obese as BMI ≥30 kg/m^2 [2]. Two milliliters of freshly collected blood were dispensed into K_2-EDTA bottles for the full blood count assay using the MINDRAY BC- 2800 automatic machine. BMI calculation classified study participants into 2 groups. Group 1 (G1), made up of non-obese people including normal weight (BMI: 18.5-24.9kg/m^2) and overweight (BMI: 25-29.9kg/m^2). Group 2 (G2) consisted of obese participants (BMI ≥30 kg/m^2). Excluded in this study were participants with diabetes, nephropathy, hepatopathy, hemopathy, heart disease, underweight, pregnant women and those who had received a blood transfusion in the last three months. Data was analyzed using the independent sample t-test (to compare significant differences between the means of two independent groups); analysis of variance which was used to check if the means of two or more groups are significantly different from each other. The Chi-square analysis and the Spearman correlation coefficients were used to test the relationship between categorical variables with the strength and direction of association between two ranked variables, respectively. A p value < 0.05 was considered statistically significant. Ethical clearance was gotten from the Ethical Review Board of the University of Bamenda and authorization was gotten from the Director of the Regional Hospital Bafoussam.

Results

Socio-demographic characteristics of study participants

Out of a total of 215 study participants males dominated with 70.7% (n=152). The most represented age group was that of 18-28 years (40.9%, n=88) and the most represented marital status was that of married participants (54%, n=116) of study participants (Table 1).

Table 1: Socio-demographic characteristics of respondents

Variable	Characteristic	Frequency	Percentage (%)	X^2	P. Value
Age groups (in years)	18-28	88	40.9	37.059	0.002*
	29-38	74	34.4		
	39-48	41	19.1		
	49-58	10	4.7		
	58+	2	0.9		
Gender	Male	152	70.7	15.607	0.004*
	Female	63	29.3		
Marital status	Single	92	42.8	44.214	0.0001*
	Cohabiting	4	1.9		
	Married	116	54.0		
	Divorce	1	0.5		
	Widowed	2	0.9		
Level of education	None	2	0.9	6.48	9.24
	Primary	21	9.8		
	Secondary	112	52.1		
	University	80	37.2		

***-statistically significant at 0.05 significance level**

Frequency of obesity in the study population

Of the 215 respondents obtained during the study, 67.9% (n=146) were non-obese and 32.1% (n=69) were obese (Fig. 1).

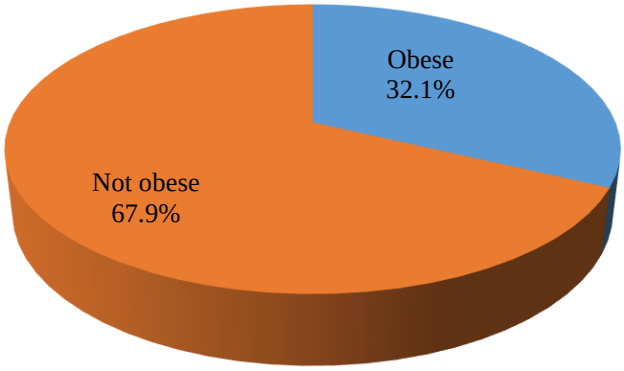

Figure 1: Prevalence of obesity

Chi-square analysis showed a significant association between gender and obesity (X^2= 15.607, p=0.004) as more than half of the women were obese, compared to men. There was also an observed significant association between age and obesity (X^2= 37.059, p= 0.002). In fact, the prevalence of obesity went from 13.64% among 18-28 year olds to 44.59% among 29-38 year olds; then to 51.22% among 39-48 year olds then began to decrease. This was also seen between marital status and obesity (X^2= 44.214, p= 0.0001).

Complete blood count profile among respondents

Description of CBC Parameters

The descriptive mean, standard deviation, minimum and maximum CBC parameter values are presented in table 3 below.

Table 2: Description of complete blood count parameters

	WBC ($\times 10^9$/ L)	Platelets ($\times 10^9$/L)	RBC (million/ mm^3)	Hb (g/dl)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (%)
Mean	5.56	273.24	5.33	14.78	45.74	86.5	27.79	32.2
Standard deviation	1.52	69.65	0.675	1.832	5.714	9.150	2.614	1.936
Minimum	2.4	56	3.26	9.2	28.4	57.9	16.3	27.6
Maximum	16.9	532	7.98	20.8	61.7	111.1	38.0	38.8

Of the 69 obese patients in this study, 8.70% had leukopenia, 2.90% had thrombocytosis, 1.4% had a low value of red blood cells, 2.90% had a low hemoglobin level, 4.3% had low hematocrit, 30.4% had microcytosis and 47.8% had hypochromia (Table 3).

Table 3: Distribution of blood count abnormalities in the two study groups

		G1 : Non obese (%)	G2 : Obese (%)	Total (%)
WBC	Leukopenia	14 (9.60)	06 (8.70)	20 (9.30)
	Normal	131 (89.7)	63 (91.3)	194 (90.2)
	Leukocytosis	01 (0.70)	00 (0.00)	01 (0.50)
Plt	Thrombocytopenia	01 (0.70)	01 (1.40)	02 (0.90)
	Normal	143 (97.9)	66 (95.7)	209 (97.2)
	Thrombocytosis	02 (1.40)	02 (2.90)	04 (1.90)
RBC	Normal	146 (100)	68 (98.6)	214 (99.5)
	Low RBC	00 (0.00)	01 (1.40)	01 (0.50)
Hb	Normal	142 (97.3)	67 (97.1)	209 (97.2)
	Low Hb	04 (2.70)	02 (2.90)	06 (2.80)
Hct	Normal	135 (92.5)	66 (95.7)	201 (93.5)
	Low Hct	11 (7.50)	03 (4.30)	14 (6.50)
MCV	Microcytosis	31 (21.2)	21 (30.4)	52 (24.2)
	Normocytosis	108 (74.0)	44 (63.8)	152 (70.7)
	Macrocytosis	07 (4.80)	04 (5.80)	11 (5.10)
MCH	Normochromia	102(69.9)	41 (59.4)	143 (66.5)
	Hypochromia	44 (30.1)	28 (40.6)	72 (33.5)
MCHC	Normochromia	72 (49.3)	36 (52.2)	108 (50.2)

	Hypochromia	74 (50.7)	33 (47.8)	107 (49.8)
Total		146 (100)	69 (100)	215 (100)

Variations in complete blood count parameters

The analysis of variance (ANOVA post hoc tests) showed a statistically significant increase in the value of red blood cells and a significant decrease in the value of MCV. These changes were most prominent in the advanced stages of obesity (morbid obesity) (Table 4).

Table 4: Multiple comparisons between blood count parameters and stage of obesity

Dependent variable	(I)Stage of obesity	(J) stage of obesity	Difference in means (I-J)	p. Value	95% confidence interval	
					Lower bound	Upper bound
RBC	**Morbid obesity**	Normal	0.73050	0.019*	0.1211	1.3399
		Overweight	0.71505	0.021*	0.1083	1.3218
		Moderate obesity	0.83481	0.008*	0.2161	1.4535
		Severe obesity	0.98271	0.004*	0.3136	1.6518
MCV	**Morbid obesity**	Normal	-9.02441	0.033*	-17.3354	-0.7135
		Overweight	-8.16872	0.053	-16.4431	0.1057
		Moderate obesity	-6.86043	0.11	-15.2976	1.5767
		Severe obesity	-10.22588	0.028*	-19.3508	-1.1009

***-statistically significant at 0.05 significance level**

Logistic regression showed that obesity has a significant effect on the combined blood count parameters (p=0.041), particularly observed at the level of red blood cells (p=0.04, CI = -0.852 to 1.2). This is presented in Table 5 below.

Table 5: Combined variations of blood count parameters and obesity

	p value	95.0 % confidence interval Lower bound	Upper bound
(Constant)	0.041*	-7.17	9.881
WBC	0.446	-0.13	0.057
Platelets	0.684	-0.002	0.002
RBC	0.04*	-0.852	1.2
Hb	0.654	-0.349	0.22
Hct	0.848	-0.134	0.11
MCV	0.921	-0.062	0.069
MCH	0.334	-0.012	0.004
MCHC	0.915	-0.139	0.155

***-statistically significant at 0.05 significance level**

The independent sample t test showed that there is a significant difference (p=0.041) in the mean red blood cells between non-obese and obese subjects in this study (Table 6).

Table 6: Mean difference in RBCs between obese and non-obese subjects

		Sig. (bilateral)	Mean difference	SD difference	95.0 % confidence interval Lower bound	Lower bound
RBC	Equal variances assumed	0.041*	0.10749	0.09828	-0.08624	0.30121

***-statistically significant at 0.05 significance level**

There was also a statistically significant negative correlation between Hb (p=0.044, r=-0.138), Hct (p=0.027, r=-0.151) and BMI

Table 7: Correlation between CBC parameters and BMI

	WBC ($\times 10^9$/L)	Platelets ($\times 10^9$/L)	RBC (million /mm^3)	Hb (g/dl)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (%)
r	-0.064	0.101	-0.092	-0.138	-0.151	0.027	-0.059	0.027

p. Value	0.35	0.142	0.18	0.044*	0.027*	0.694	0.389	0.694

***-statistically significant at 0.05 significance level**

Discussion

This present study had a total of 215 respondents including 67.9% (n=146) non-obese and 32.1% (n=69) obese subjects. This result is similar to that of Koffi et al., [7] who found a prevalence of 38.1% obesity among workers at the autonomous port in Abidjan. These results are also similar to those of the study by Bita et al [8] who reported a prevalence of obesity of 33.3% among women in the Foto village in the West Cameroon region and 37% in hotel environment [8]. This high prevalence could be explained by the fact that in most Cameroon communities, the preparation of essential dishes is made from lipids (red oil), which to this is added the sedentary lifestyle and the positive meaning that society gives to being overweight.

The socio-demographic characteristics of the respondents studied in this study were: age, gender, marital status and level of education. In our study, the prevalence of obesity was higher in women than in men. These results corroborated those obtained in a study conducted by Bita et al in the city of Douala, Cameroon, in 2012, on a sample of 552 workers showing a general prevalence of obesity at 23.4 %, including 36.1% in women and 17.8% in men [8]. This is explained by the fact that body composition varies according to sex: a woman has a higher fat mass than a man of the same weight and height, i.e. respectively 20-25% and 15-20% of the body mass in young adults [9, 10]. The anatomy of women predisposes them to gain weight more easily than men. The significant variations in the prevalence of obesity in the different age groups are different from those obtained in a study conducted in 2003, in which the prevalence of obesity increased from 2.5% among 18-24 year olds to 17.6% among 65-69 year olds. This could be explained by the difference in the race of the population studied and by the weakness of the workforce in the present study. The prevalence of obesity increases steadily with age in adults; this is explained by the body composition which changes with age with a decrease in lean mass and an increase in fat mass [11]. The subjects at the highest risk of gaining weight are men aged 25 to 34 and women aged 25 to 44 who are already overweight [5]. The decrease observed in older subjects is explained by the decrease in lean mass and may be due to a survival bias linked to early excess mortality in the most obese subjects. The significant association between marital status and obesity were inline with those obtained by Cheick Oumar [12] in a study on the particularities of obesity in medicine. In this study, the notion of family obesity in one or more family members was found in 57% of cases; in 38.8% of cases the wife or husband was obese; in 34.7% of cases both spouses are obese [12, 13]. More over, the reality of familial obesity is indisputable. Obesity is indeed a heterogeneous disorder involving multiple factors and resulting from interactions between genetic status, behavior and environment.

In this study, the significant variations observed in the parameters of the hemogram are similar to those obtained by Maryam et al., 14] in a study which showed a positive correlation between the erythrocyte indices (RBC, HCT, HGB , MCV, MCH, MCHC) and normal weight but negative between erythrocyte indices and overweight/obesity [14]. So, the more the weight increases, the more the value of the indices decreases. However, our results did not show a decrease in MCHC in obese subjects. The negative correlation between BMI and RBC indices for overweight/obesity may result from pro-inflammatory cytokines from adipocytes and free radicals from oxidative stress. The increase in free radicals which affects the membrane proteins of red blood cells, alters their natural structure, increases fragility, decreases survival and causes anisocytosis by the increased proportion of circulating immature erythrocytes [14]. To compensate for the reduction in the lifespan of red blood cells, the body increases the production of new red blood cells, which leads to an increase in the number of red blood cells [15]. This may explain the appearance of false polycythemia in the advanced stages of obesity. Weight gain is also associated with increased platelet values. These results are corroborated by those obtained by Maryam et al., in a study which showed a positive correlation between obesity and platelets [14]. A positive association between BMI and platelet count in overweight/obese individuals indicates the presence inflammation in these subjects [15]. Increased thrombocytosis in individuals with metabolic diseases and those who were overweight/obese could result from an inflammatory process and platelet activation which plays a key role in accelerating atherothrombosis [16].

Obesity leads to a decrease in the number of red blood cells, hemoglobin level, hematocrit and other erythrocyte indices (MCV, MCH). Obesity is increasingly associated with decreased blood iron levels in children, adolescents and adults alike. Several studies have shown similar results. These include the case of Nead et al who, in 2004, published an article that evaluated the cross-sectional relationship between the weight of children and adolescents aged between 2 and 16 years and their iron status [17]. In fact, statistical analyses revealed that overweight and obese children and adolescents were twice as likely to have iron deficiency, compared to normal-weight children and adolescents. The study by Maryam et al also showed a negative correlation between erythrocyte indices (RBC, HCT, HGB, MCV, MCH, and MCHC) and overweight/obesity [14]. First, this association could be explained by an iron-deficient diet. Indeed, it is suggested that people with an obesity problem have a diet providing a low iron intake, which would induce a decrease in blood iron levels. It is possible that the iron requirements of obese people are higher than people

of normal weight due to their greater blood volume [18, 19, 20]. The state of inflammation present with obesity constitutes the second hypothesis that could explain the association between the increase in BMI and the decrease in the values of the indices.

Conclusion

This present study had as objective to study the relationship between obesity and the hemogramme profile of people attending the Regional Hospital of Bafoussam, it appeared that the frequency of obesity in the study population was 32.1%. The effect of obesity and the variations observed on the blood count profile are characterized by: the appearance of false polycythemia in morbid obesity, decrease in the average values of white blood cells, significant reduction red blood cells, hemoglobin and hematocrit in obese people and the significant increase in the mean value of platelets in obese people. In sum, the interpretation of the complete blood count in obese subjects should take into account the fact that the values of red blood cells, white blood cells and erythrocyte indices may be lowered while the value of platelets is high in this group.

Author's contribution

LHS, Study conception and design; PJ, writing of the manuscript; EN, critical revision of the manuscript; LHS,EN, Study design, supervision of data collection and critical revision of manuscript; PJ, Data collection and analysis. All authors gave their consent for publication. All authors read and approved the final manuscript.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

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