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Original Research Paper

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INDICES OF ATHEROGENICITY AND CARDIOVASCULAR RISK IN A SENEGALESE ADULT POPULATION

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ABSTRACT

INTRODUCTION: Cardiovascular diseases are the leading cause of death worldwide, with approximately 17.7 million deaths annually. Nearly 75% of these deaths occur in low-income countries, such as Senegal. Lipid parameters (triglycerides, total cholesterol, LDL, HDL) are often used to predict cardiovascular risk. However, a combined index may show a stronger association with cardiovascular disease than the individual parameters. It is therefore relevant to evaluate indices of atherogenicity and their relationship with other cardiovascular risk factors.MATERIALS AND METHODS: This was a retrospective cross-sectional analytical study conducted from March 1st to May 31st, 2020, at the medical biochemistry laboratory of Cheikh Anta Diop University. Subjects aged 20 years or older who complied with the fasting requirements were included. Subjects on medication or with a known condition that could interfere with the assays were excluded. Clinical evaluation was performed before each blood sample collection: interview, medical history, weight, height, and blood pressure. After a 12-hour fast, 5 ml of venous blood was collected from the antecubital fossa (the bend of the elbow) in dry tubes. The samples were centrifuged at 3000 rpm for 5 minutes. The serum was collected in labeled tubes with identification numbers. The assays were performed within one hour of collection. Total cholesterol, HDL, TGD and blood glucose were measured using adapted enzymatic methods on the Mindray analyzer; other parameters were calculated.**RESULTS:** We studied 864 individuals with an average age of 37.9 years and a male-to-female ratio of 1.13. A high BMI prevalence of 52.9% was observed. The prevalence of hypertension was 39.3%, with 13.8% having mixed hypertension; systolic hypertension was 34.5% and diastolic hypertension 18.5%. The prevalence of dyslipidemia was 69.5%, with hyper-LDLemia being the most prevalent at 38%, followed by hyper-total cholesterol at 37%. Atherogenicity indices showed a statistically significant positive correlation with other cardiovascular risk factors, with the exception of HDL, which showed a negative correlation.**CONCLUSION:** Cardiovascular diseases are the leading cause of death worldwide, accounting for 31% of all deaths according to the WHO in 2017. Atherogenicity indices are positively correlated with risk factors and lipid parameters, with the exception of HDL, which shows a negative correlation. These indices could offer greater sensitivity for assessing cardiovascular risk than the isolated analysis of lipid parameters.

KEYWORDS : dyslipidemia, atherosclerosis, atherogenicity indices, cardiovascular risks.

INTRODUCTION:

Cardiovascular diseases are the leading cause of death worldwide, accounting for an estimated 31% of total global mortality according to the WHO in 2017 (1) Furthermore, nearly 75% of deaths from cardiovascular diseases occur in low-income countries such as Senegal. (2) In sub-Saharan Africa, the prevalence of dyslipidemia varies by region; a prevalence of 44.2% was found in Chad (3) and up to 61.1% in Senegal . (4)

Identifying and appropriately managing cardiovascular risk factors could help prevent cardiovascular disease. Lipid

analysis, a simple test available in all laboratories, is one step in this prevention strategy (5). (6) To refine the risk assessment, different lipid index ratios are proposed. (7) This has several potential advantages that could complement, or even replace, individual values. (8) It is clear that a single index that combines information from two individual indices should show a stronger association with cardiovascular disease . (7) (9)

Thus in this work the objective is to evaluate different indices of atherogenicity such as Castelli I; Castelli II; AI and AIP in a Senegalese population and their relationships with different cardiovascular risk factors.

Methods:

This retrospective study included 864 patients, employees of a private company in Dakar, aged 22 to 64 years, who underwent routine annual checkups between March 1 and May 31, 2020. Subjects aged 20 years or older who adhered to the fasting requirements were included . Patients undergoing treatment that could interfere with lipid parameter measurements or developing a known condition that could interfere with the various assays were excluded. Total cholesterol, HDL cholesterol, triglycerides, blood glucose, and uric acid levels were measured using enzymatic methods on an automated biochemistry analyzer. Mindray model BS200. LDL cholesterol was calculated using the Friedewald formula. (10). Atherogenicity indices were calculated using the Castelli formula (CRI-I): TC/HDL-C (Normal value: <4.5), Castelli II (CRI-II): LDLC/HDL-C (Normal value: <3.5). Plasma atherogenic index (AIP): LOG TG/HDL-C (Normal value: <0.1). Atherogenic index (AI): (TC – HDL-C)/HDL-C (Normal value: <2). Dyslipidemias were defined according to the National Cholesterol Education Program (NCEP) criteria (11) . Data were collected using Excel 2010 and analyzed using SPSS Statistics 24. A p-value <0.05 was considered statistically significant.

RESULTS:

The average age of our population was 37 ± 9.3 years, with a range from 22 to 64 years. The 22-35 age group was the most represented (Figure 1). Males were predominant, with a male-to-female ratio of 1.13 (Figure 2).

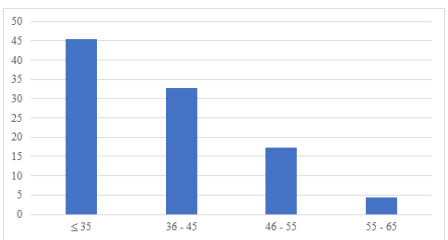


Figure 1: Distribution of the study population by age

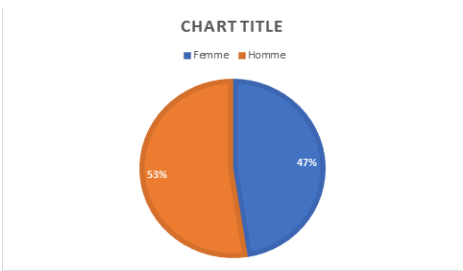


Figure 2 : Distribution of the study population by sex

More than half of our population (52.9%) was overweight or obese (Figure 3). Furthermore, Table I shows that 39.3% had elevated blood pressure, distributed as follows: 13.8% had mixed hypertension, 34.5% had systolic hypertension, and 18.5% had diastolic hypertension. Finally, 3.7% of the population had a blood glucose level above 1.26 g/L (Table II).

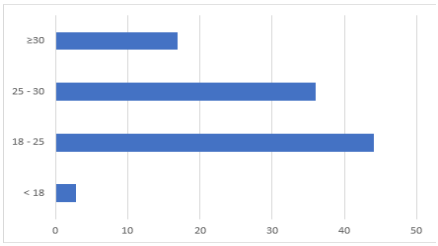


Figure 3: Distribution of the population according to body mass index

Table I: Distribution of the population according to blood pressure

		Eff	%
NOT	Normal	565	65.5
	Increased	298	34.5
PAD	Normal	703	81.5
	Increased	160	18.5
HTA	No	524	60.7
	Yes	339	39.3
Mixed Hypertension (systolic diastolic)		119	13.8

Table II: Distribution according to blood glucose

Blood glucose	eff	%
Normal	832	96.3%
High	32	3.7%

The prevalence of dyslipidemic individuals in the study population was 69.5% with a slight predominance of hyper-LDLemia at 38% followed by total hypercholesterolemia at 37% (Figure 4).

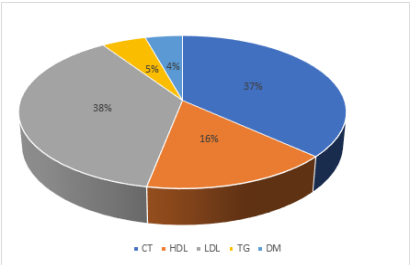
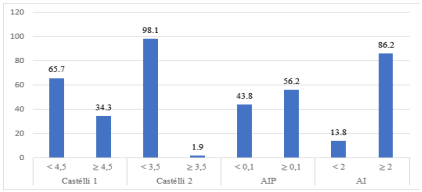


Figure 4: Prevalence of different types of dyslipidemia

Atherogenic index abnormalities were found in 91.8% of the population with 67.7% for Castelli I, 1.9% for Castelli II, 56.2% for AIP and 86.2% for AI.



Atherogenicity indices

Table III shows that the atherogenic indices had a statistically significant positive correlation with the cardiovascular risk factors studied, namely age, BMI, blood pressure, UA, and blood glucose. A correlation was also observed with lipid profile parameters, except for HDL cholesterol, which showed a negative correlation with the atherogenic indices, seemingly confirming its protective role.

Atherogenicity indices and cardiovascular risk factors

	Castelli 1		Castelli 2		AIP		AI	
	r	p	R	p	r	p	r	p
Age	,278**	<0.001	,260**	<0.001	,235**	<0.001	,278**	<0.001

GLUE	,236 **	<0.002	,228 **	<0.002	,209 **	<0.002	,236 **	<0.002
AT	,281 **	<0.004	,238 **	<0.004	,353 **	<0.004	,281 **	<0.004
CHOL	,516 **	<0.005	,534 **	<0.005	,239 **	<0.005	,516 **	<0.005
HDL	-,696 **	<0.006	-,654 **	<0.006	-,679 **	<0.006	-,696 **	<0.006
SORTING	,618 **	<0.007	,507 **	<0.007	,917 **	<0.007	,618 **	<0.007
LDL	,673 **	<0.008	,726 **	<0.008	,289 **	<0.008	,673 **	<0.008
NOT	190 **	<0.009	,153 **	<0.009	,256 **	<0.009	190 **	<0.009
PAD	,202 **	<0.010	180 **	<0.010	,198 **	<0.010	,202 **	<0.010
BMI	,286 **	<0.011	,259 **	<0.011	,279 **	<0.011	,286 **	<0.011

DISCUSSION :

Lipid profile analysis is a powerful diagnostic tool for establishing patients' cardiovascular status and monitoring treatment effectiveness. Indeed, the severity of cardiovascular diseases requires identifying at-risk individuals to better target therapeutic efforts. Typically, individual lipid, apolipoprotein, and lipoprotein values are used to assess cardiovascular risk. However, another approach exists based on calculating ratios of different lipid indices. Calculating these ratios can aid in risk assessment, particularly in situations where LDL levels are below the target range. Furthermore, these ratios provide information on risk factors that are difficult to analyze routinely (e.g., small LDL particles). (8)

This is why our study focused on the lipid profile and the different indices of atherogenicity.

HyperLDLemia is the most frequent dyslipidemia (38%), closely followed by hypercholesterolemia (37%). This predominance of hyperLDLemia was also reported by Cissé et al. at Le Dantec, Doupa et al. at St. Louis, and Erem et al. in Turkey. However, most authors found a predominance of hypercholesterolemia (19), (17), (22), (23), (24). This could be explained by the fact that these authors did not consider hyperLDLemia, which is almost always associated with hypercholesterolemia.

Atherogenicity indices were disrupted in 91.8% of our population.

The TC/HDL ratio, or Castelli index I, was above normal in 67.7% of cases. This is the most frequently used ratio to express the respective influences of cholesterol fractions that have harmful or beneficial cardiovascular effects. The two components of the TC/ HDL ratio are measured directly. A large and varied number of studies have demonstrated the superiority of this ratio as a CVD risk index compared to LDL cholesterol or total cholesterol (25) (26) (27). In our study, this index has a statistically higher correlation of 82 compared to other cardiovascular risk factors. This is consistent with other studies such as S. Bhardwaj et al. in 2013. (8) (28)

The LDL/HDL ratio, or Castelli II index, is composed of two lipids that are the primary targets of therapeutic measures. However, its limitation lies in the fact that the LDL component is not measured but calculated, as is most often the case. Our results showed a small percentage increase in the Castelli II ratio. A correlation with other cardiovascular risk factors was observed.

As for the AIP or log TG/HDL ratio, it is more closely associated with insulin resistance and metabolic syndrome, which are also cardiovascular risk factors. The distinctive feature of this ratio is that it does not take LDL cholesterol into account. However, it reflects the importance attributed to triglycerides as a factor modulating cardiovascular risk, and thus it could complement the TC/HDL ratio. AIP was elevated in 86.2% of our population, a prevalence higher than that of dyslipidemias, suggesting that individuals with a normal lipid profile may have an AIP abnormality. We found a strong, statistically significant correlation between AIP and other cardiovascular risk factors.

Furthermore, the study conducted by Nwagha et al. (29) showed that in situations where other atherogenic risk parameters such as triglycerides and HDL cholesterol appear normal, the AIP can be a diagnostic alternative. Some studies have demonstrated its role in predicting cardiovascular risk and treatment efficacy. (30) The AIP has a higher sensitivity that reflects the interaction between atherogenic and protective lipoproteins.

The atherogenic index (AI), which measures the ratio of LDL-C , VLDL-C, and IDL-C lipoprotein fractions to HDL-C (good cholesterol), reflects the atherogenic potential of the entire spectrum of lipoprotein fractions. Non- HDL-C is the second target of treatment after LDL-C according to the ATPIII guidelines (31), particularly in individuals with hypertriglyceridemia (8). Studies have shown that non- HDL-C is similar to Apo-B in assessing atherogenic cholesterol and lipoprotein load (32). In our study, this index was abnormal in 56.2% of cases. atherogenic indices showed a positive correlation with cardiovascular risk factors and lipid parameters, except for HDL cholesterol, which showed a negative correlation with these indices. This appears to confirm its protective role in cardiovascular events. Our study was limited by a lack of information regarding medical history and the presence of other cardiovascular risk factors. Thus, hypertension and diabetes were defined based on blood pressure readings and hyperglycemia, respectively, which could bias their prevalence in our study.

The prevalence of hypertension in our population was 39.3%. These results are confirmed in studies conducted in Senegal (12) (13) and Algeria (14). Lower prevalence rates were found in Mauritania. (15)

Regarding obesity, our population consisted of 16.9% and 36% who were overweight; a result that is high compared to the results of Cissé et al., who found 0.81% obese. (12) However, these figures are comparable to those found in Mauritania, with 20.9% obese and 25.7% overweight. (15)

In our population, 3.4% were diabetic; these results are consistent with the results of Cissé et al. in Dakar in 2006 (12) and slightly exceed those found in Mauritania in 2006, which were 1.9%. (15)

Our results revealed a high prevalence of dyslipidemia (69.5%). These figures are comparable to those found in epidemiological surveys on cardiovascular risk factors carried out in St Louis and Guéoul. (16)

These results show a sharp increase in the prevalence of dyslipidemia compared to those found by CISSE et al. in 2006 in Senegal (12) and Tiahou et al. the same year in Ivory Coast (17) with 36% and 39% respectively.

Our results far exceed those found in Algeria (15.9%) and Mauritania (14.8%) and are close to those observed in industrialized countries. (18) (19) (20) (21)

CONCLUSION :

Atherogenic indices may have greater sensitivity for

assessing cardiovascular risk compared to lipid parameters studied in isolation. The AI and AIP indices are elevated in both dyslipidemic and non-dyslipemic individuals. The elevated ratios in the latter demonstrate the value of their measurement even when lipid parameters are normal. These indices all showed a positive correlation with other cardiovascular risk factors and lipid parameters, except for HDL, which had a negative correlation, seemingly confirming its protective role.

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