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Research Article

# Importance of Hypercholesterolemia in the Occurrence of Atherosclerosis

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**Abstract**

**Aim:** The westernization of the lives of Africans has led to the emergence of new pathologies including atherosclerosis. One of the factors in the occurrence of atherosclerosis attacks is hypercholesterolemia, hence the importance of measuring total cholesterol and its fractions in all adults, especially in subjects with at least one cardiovascular risk factor. A lipid check-up is therefore necessary for all adults aged 30 years and older every year.

**Patients and Methods:** This is a case-control study from February 2017 to October 2018 involving 148 subjects including Cardio-ischemic patients 49 and Controls, 99 and was conducted in the Cardiovascular Physiology Laboratory of the Department of Animal Biology of the Faculty of Science and Technology of the University CHEIKH ANTA DIOP of Dakar (SENEGAL).

**Results:** From the different assays carried out, it appears that in the controls, the total cholesterol level varies between 1.07 and 3.52 g/l; the HDL level varies between 0.30-1.06 g/l; the LDL level varies between 0.11-1.98 g/l; the glycemia level varies between 0.63-1.55 g/l. In carriers of ischemic heart disease, total cholesterol level varies between 1.03-4.56 g/l; HDL level varies between 0.24-0.75 g/l; LDL level varies between 0.68-3.41 g/l; blood sugar level varies between 0.83-2.45 g/l. In the whole study population, HDL versus AI1: 0.91-8.85 with 49 subjects with AI1 >4.5 and LDL versus AI2: 0.51-3.50 with 9 subjects with AI2 >3.5, i.e. 6.25% of the sample. The LDL are atherogenic especially those that are oxidized, but if the LDL are high the probability that many are oxidized is high and may even be the cause of cardiovascular crisis especially in patients with an existing cardiovascular risk factor. The standard ranges from 1.23 to 2.57g/l.

**Conclusion:** The dosage of cholesterol and its fractions is of utmost importance for everyone, especially for people at risk of cardiovascular disease.

**Keywords:** Heart disease; Cardiovascular; Ischemia; Atherosclerosis; Hypercholesterolemia

## Introduction

Cardiovascular diseases, once the prerogative of Western industrialized countries, have now become a public health problem in Africa, particularly in large cities. Indeed, Africans and Orientals were not predisposed to coronary heart disease. But with the westernization of African life, this chronic and deadly disease has not only emerged but has become highly prevalent. Cardiovascular diseases are essentially western pathologies. In 1990, 33% of the deaths in France in 1990 were cardiovascular ischemic in men and 23.7% in women [1,2]. In the USA, ischemic heart disease is the main cause of death, killing more than 400,000 people per year [3,4]. One out of 5 deaths is due to ischemic heart disease, in addition 120,000,000 people are currently living with the pain caused by ischemic heart disease and/or heart problems [6,7]. Indeed Africans and Orientals were not predisposed to coronary heart disease. But with the westernization of African life, this chronic and deadly pathology has not only appeared but has become highly prevalent [11,12]. Ischemic heart disease is the leading cause of hospitalization in cardiology clinics. The process of atherogenesis takes place gradually over several decades before clinical manifestations occur. Myocardial and cerebral infarction, obliteration of a lower limb artery are the most frequent of these manifestations [13,14]. This underlines the importance of early prevention, which should ideally be implemented before the lesions have formed or at a stage when they may still regress [15,16,19]. This prevention requires knowledge of the factors that trigger atherogenesis. One of these factors is hypercholesterolemia. The importance of hypercholesterolemia in the process of atherosclerosis is the objective of this study.

## Study Framework and Methods

This case-control study took place in the cardiology clinic of the Aristide Le Dantec hospital where the cases, i.e. patients with ischemic heart disease, were collected, the Cheikh Anta Diop University (UCAD) where the controls, consisting of UCAD administrative staff, were collected, and the nutrition and cardiovascular physiology laboratories served as the setting for the various biological tests. This is a case-control study spanning two academic years: from February 2017 to October 2018.




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**Table 1:** Study Contingency.

| | Cases | Witnesses | Total |
|---|---|---|---|
| **Presentations** | 30 | 37 | 67 |
| **Not Exposed** | 1962 | 62 | 81 |
| **Total** | 49 | 99 | 148 |

**Sampling:** Looking at records from 2014 to May 2018, we identified 108 records of cardio-ischemic patients.

**Inclusion Criteria:** Cases are patients with ischemic heart disease. Controls are apparently healthy people who are neither diabetic nor hypertensive; only people at least 30 years of age are involved. The study included 148 subjects, as follows:

- Cardio-ischemic patients, $49
- Witnesses, 99

For all intents and purposes, we remind you that all persons entering the study were collected on the basis of their consent.

**Exclusion Criteria**: We excluded from the study all individuals in the control lot with blood glucose levels greater than 1.70g/L. The biological tests carried out during this work are glycemia, total cholesterol, HDL cholesterol, LDL cholesterol.

### Statistical analysis of the data

The event studied is hypercholesterolemia and the pathology is atherosclerosis (Table 1).

The probability of being exposed in Cases, p1

P1=y/M1=62

The probability of not being exposed in Witnesses, p2

P2=b/M2=38%.

The two probabilities being different rejected the null hypothesis.

Determine the prevalence of hypercholesterolemia in the study sample, P.

P=number of cases/number of subjects observed

P=49/148 =33%, P >20%, which means that the event studied, i.e. hypercholesterolemia, is not rare in the population.

Determining the exposure scores in each group:

- CEC Cases = a/c = 30/19 = 1.58
- CET Controls = b/d = 37/62 =0.60
- Exposure Rating Ratio (OR),

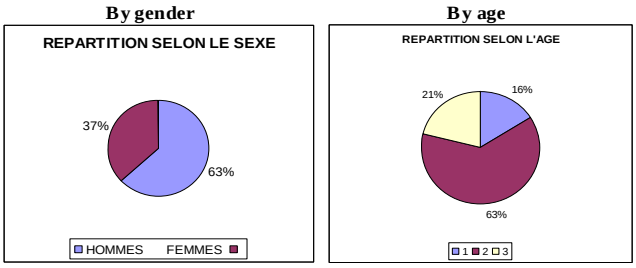
RC = ad/bc =30* 62/19* 37 =2.65

CR >1, the association is positive: the risk of disease is higher in Cases than in Controls.

OR= 2.65 means that a subject with cholesterol > to

239mg/dl has a 65% higher probability of developing atherosclerosis.

Let us determine the 95% Confidence Index (CI) by the semi-exact CBM method.




**Graphe 1:** The sample was divided into the following categories.
**1:** 30 to 45 years old, **2:** 45 to 65 years old, **3:** 65 to 95 years old.

- **Cholesterolemia**
- **Total Cholesterol**

RC = 2.65; IC = $IC_{95\%} = RC \pm e\left[\pm U_{\alpha}\sqrt{\left(\frac{1}{a}\right)+\left(\frac{1}{b}\right)+\left(\frac{1}{c}\right)+\left(\frac{1}{d}\right)}\right]$

$IC_{95\%} = 2,65 \pm e\left[\pm 1,96\sqrt{\left(\frac{1}{30}\right)+\left(\frac{1}{37}\right)+\left(\frac{1}{19}\right)+\left(\frac{1}{62}\right)}\right]$

IC= [1.38-5.70], the null hypothesis is rejected because 0 does not belong to the confidence interval.

All the theoretical numbers are higher than 5, hence the application of the formula of Ch2 of MH.

$X^2 = \left[(ad)-(bc)\right]^2 \ (T-1)/M1\ X\ M2\ X\ E1\ X\ E0$

$X^2$ = 7.47 at one degree of freedom; P<10-3

## Results and Analysis

In this Control batch (Graphe 1 and Figure 1), the cholesterol level varies from 1.07 to 3.52 g/l. Cholesterol levels are significantly lower than those of cardio-ischemic patients, as indicated by the statistical parameters. The average value is 1.81g/l, with this value, one could believe that there are no hypercholesterolemic subjects, but in this lot, there are 15 hypercholesterolemia subjects, i.e. 16.66% of the Control lot. The variance is 0.47 with a standard deviation of 0.69g/l and a coefficient of variation of 0.38, which presents the same dispersion as the patients' lot. The norm varies from 1.12 to 2.50 g/l. These values (Figure 2) do not reflect the true value before the first attack of ischemic heart disease occurs, because as soon as a cholesterol-lowering treatment is instituted, cholesterol levels are reduced by 10 to 15% in patients. Total cholesterol in cardio-ischemic patients ranges from 1.03 to 4.56 g/l; with 24 patients with hypercholesterolemia. That is 50% of the patients. It should be noted, however, that these are patients under treatment, hence the low level of hypercholesterolemia.

The statistical parameters are as follows: The mean is 2.78g/l with

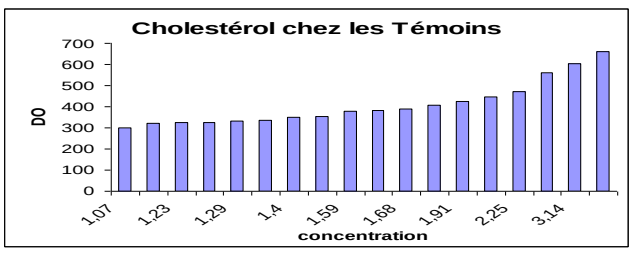



**Figure 1:** Cholesterol Levels in Relatively Healthy Donors.

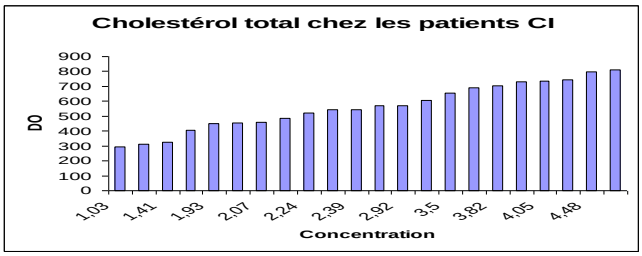



**Figure 2**: Cholesterol levels in IC patients.

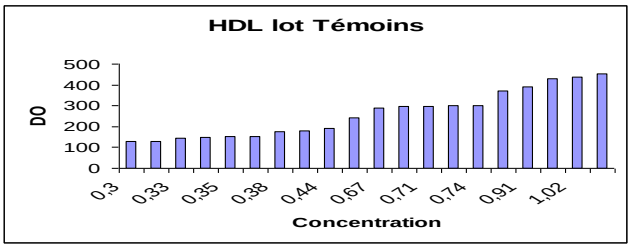



**Figure 3:** HDL Cholesterol Levels in Relatively Healthy Donors.

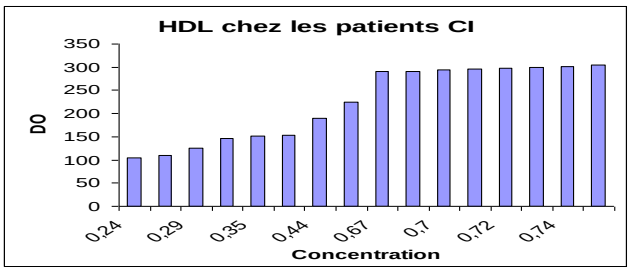



**Figure 4:** HDL Cholesterol Levels in CI Patients.

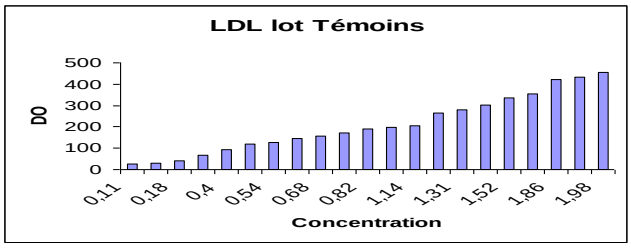



**Figure 5:** LDL Cholesterol Levels in Relatively Healthy Donors.

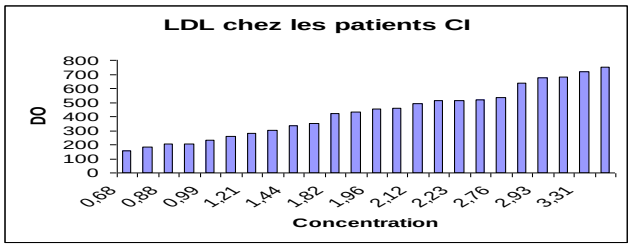



**Figure 6:**

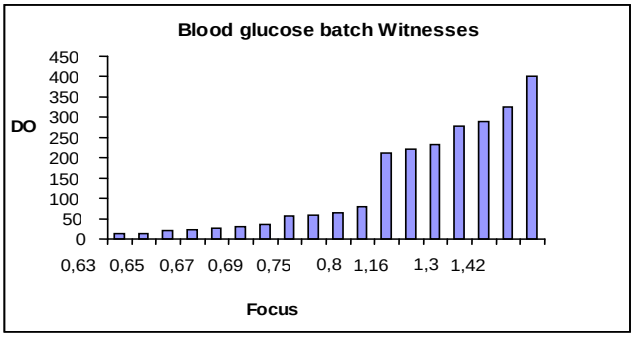



**Figure 7:** Blood glucose levels in relatively healthy donors.

a standard deviation of 1.07g/l and a variance of 1.15 with a coefficient of variation of 0.38, which means that the dispersion is relative. The norm varies from 1.71 to 3.08g/l. In the control batch (Figure 3), HDL cholesterol ranges from 0.30 to 1.06 g/l, which is much lower in the patient batch. It should be noted that in this batch there are 14 subjects whose HDL is < the norm, i.e. 35% in the study batch. There are also 12 subjects whose HDL is ≥ 0.75 g/l, in those it confers them a longevity syndrome related to coronary diseases.

The statistical parameters are as follows: The mean is 0.62g/l with a standard deviation of 0.256g/l, a variance of 0.066 and a coefficient of dispersion of 0.41 approximately the same range as total cholesterol. The norm ranges from 0.37 to 0.87 g/l (Figure 4). HDL-cholesterol in cardio-ischemic patients varies from 0.24 to 0.75 g/l with a mean of 0.53g/l, a variance of 0.037 and a standard deviation of 0.19g/l and a coefficient of variation of 0.36. This variation is of the same magnitude as total cholesterol in both patients and controls (Figure 5). There are 30 cardio-ischemic patients, 18 of whom are males with HDL cholesterol <0.40g/L and 12 patients with HDL cholesterol <0.35g/L. Patients whose HDL is < normal have an increased cardiovascular risk that increases inversely to HDL levels. These are the patients in whom the cardiovascular risk is no longer demonstrated, they are at greater risk of a cardiovascular attack as HDL decreases. The standard ranges from 0.34 to 0.72 g/l.

In the Control (Figure 6) lot the variation is 0.11 to 1.98 g/l with 29 subjects with hyperLDLLemia, i.e. 31% of the lot studied. The mean of 0.95g/l suggests that all subjects are normolopidemic in terms of LDL cholesterol with a standard deviation of 0.69g/l and a variance of 0.35 with 0.62 range of dispersion. The norm ranges from 0.36g/l to 1.54g/l (Figure 6). The coefficient of dispersion of 0.43 shows a wider distribution compared to the other constants and a mean of 1.90g/l, which may suggest that all patients have an atherogenic risk related to LDL cholesterol because this mean is higher than the norm of 1.30g/l. The standard deviation is 0.82g/l with a variance of 0.67. LDL cholesterol ranges from 0.68 to 3.41 g/l, in the lot studied there are 34 patients with hyperLDL, representing 70.8% of the lot. LDLs are atherogenic, especially those that are oxidized, and if LDLs are high, the likelihood of many being oxidized is high and may even be the cause of a cardiovascular attack, especially in patients with an existing cardiovascular risk factor. The standard ranges from 1.23 to 2.57 g/l.

In the Controls (Figure 7), the blood glucose level was used as an inclusion argument, as all diabetics are excluded from our study. In this lot the blood sugar level varies from 0.63 to 1.55 g/l.

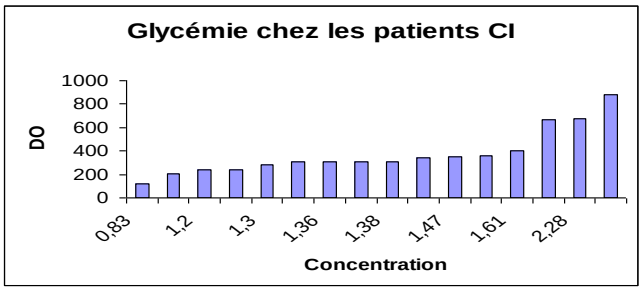



**Figure 8:** Blood glucose levels in CI patients.

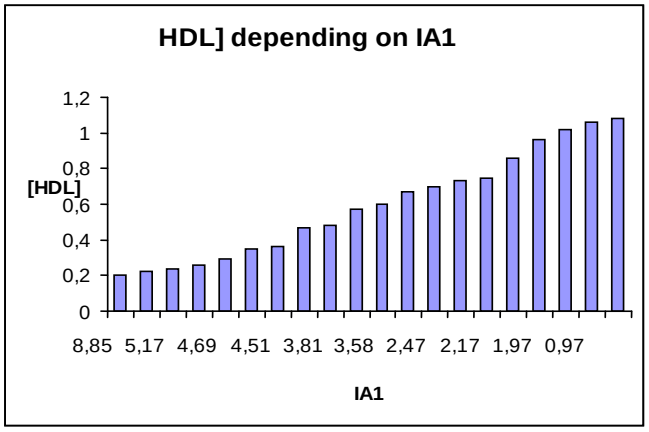



**Figure 9:** HDL Cholesterol as a Function of AI1.

The statistical parameters are as follows:

The mean is 0.93g/L, a standard deviation of 0.30, a variance of 0.094 and a coefficient of dispersion of 0.32. The norm ranges from 0.63 to 1.23 g/l (Figure 8). The mean is 1.49g/L, with a standard deviation of 0.41g/L, a variance of 0.17 and a dispersion of 0.27, which shows that in this lot the sample, is poorly distributed. Blood glucose levels range from 0.83 to 2.45g/l, of the 49 patients there are 20 known diabetics, or 40% of the lot.

It should be noted, however, that diabetes complicates atherosclerosis (Figure 9). The variation of IA1 is from 0.91 to 8.85, IA1 is one of the predictive parameters of the occurrence of atherosclerosis crisis. It highlights the risk of atherogenicity [20,23]. There are 49 subjects in this lot with an AI1 > 4.5, i.e. 35% of the lot studied.

The statistical parameters are as follows:

The mean is 3.58, a standard deviation of 1.92, a variance of 3.67, and a coefficient of dispersion of 0.54. The norm ranges from 1.66 to 5.50 (Figure 10). The variation of IA2 is from 0.51 to 3.50. IA2 is also one of the most predictive parameters of the occurrence of cardiovascular crisis. The IA2 highlights the atherogenic risk mainly related to LDL cholesterol, which is the most atherogenic cholesterol. There are 9 subjects in this lot with AI2 > 3.5, i.e. 6.25% of the sample. The statistical parameters are as follows: The mean is 1.32, a standard deviation of 0.95, a variance of 0.89, and a coefficient of dispersion of 0.73 showing that in this lot the sample is highly dispersed. The norm ranges from 0.37 to 2.27.

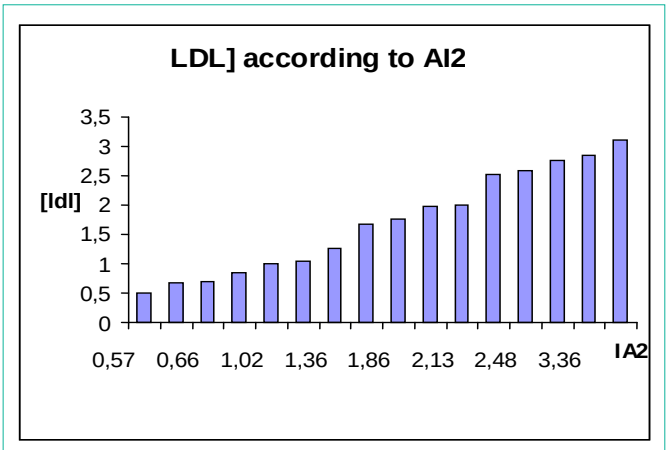



**Figure 10:** LDL cholesterol levels as a function of AI2

## Discussion

The link between hypercholesterolemia and atherosclerotic diseases is particularly well established, especially for coronary pathologies. Elevation of Total Cholesterol and LDL Cholesterol is associated with an increased risk of coronary heart disease. It is multiplied by 2 when total cholesterol goes from 2 to 2.5 g/l and by 3 when it goes from 2 to 3 g/l. There does not seem to be a threshold at which coronary risk would appear. However, the relationship is much less pronounced in women and in subjects over 65 years of age [24]. In Africans, it is desirable not to exceed 2g/l total cholesterol and 1.30g/l LDL cholesterol. From 2.39g/l total cholesterol, the cardiovascular risk becomes permanent. In our study the standard of total cholesterol varies from 1.12 to 2.39 g/l.

HDL (High Density Lipoprotein) lipoproteins are involved in the "reverse transport" of cholesterol, allowing its reuptake at the periphery and its transport to the elimination pathways [30,35]. The increase in HDL-cholesterol is therefore a priori rather protective [36]. An increase in HDL-C of 0.01 g/l is accompanied by a 2% reduction in the risk of coronary heart disease in men and 3% in women [37]. However, it should be pointed out that the HDL-C concentration is lowered by smoking and hypertriglyceridemia, and that, conversely, moderate alcohol consumption (a glass of wine of about 30 cl at lunch and dinner) and especially oestrogens increase the HDL-C concentration in women (which probably explains part of the female protection against coronary risk, especially up to the menopause) [39,40].

- HDL-C < 0.35 g/l (French recommendations) [41]
- HDL-C < 0.40 g/l (USA) [41,42]

May be considered an additional risk factor. The American standard is close to the African standard, which is 0.63g/l in this study. It is especially important for medical biologists to take into account not only IA1 but also IA2 for a correct interpretation of the lipid profile. Because of the inverse relationship between coronary risk and LDL-C on the one hand and HDL-C on the other hand, it has been proposed to use the ratios

- IA1 = [total cholesterol/HDL-C]
- IA2 = [LDL-C/HDL-C]

As predictors of coronary risk. Coronary heart disease risk increases particularly when IA1 exceeds 5 and IA2 ≥3.5 [20].

## Conclusion

The determination of cholesterol and its fractions is of paramount importance for everyone, especially for people at risk of cardiovascular disease. We have also just confirmed through this study, the crucial role of hypercholesterolemia in the development of atherosclerosis, particularly coronary artery disease, the risk of mortality from ischemic heart disease rises in parallel with the rise in cholesterol levels. Although there is no cholesterol threshold value at which cardiovascular mortality rises, the risk only becomes significant at a total cholesterol level above 239mg/dl. Indeed, there is a variability of about 10% in cholesterol levels from one day to the next. Once hypercholesterolemia has been demonstrated, we will try to specify the share of LDL cholesterol in this elevation. In fact, above 240mg/dl of total cholesterol, LDL cholesterol is almost always high, i.e. above 130mg/dl. Indeed cardiovascular diseases have a multifactorial etiology, and we have to treat patients and not isolated risk factors, hence the importance of assessing the overall cardiovascular risk.

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