

Determinants of Non-High Density Lipoprotein-Cholesterol in Bantu Central African Type 2 Diabetic Patients

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ABSTRACT

AIM: To define non-HDL-C and to assess its relationship with CVD risk factors in Black Bantu Central African T2DM patients with glycemic control.

METHODS: This cross-sectional survey was conducted at LOMO MEDICAL Clinic, Kinshasa, capital and megacity of Democratic Republic of the Congo (DRC), between November 1st 2007 and December 30th, 2008.

RESULTS: Only LDL-C, TG and dry salted fish were significantly, positively and independently correlated with HD2-among inactive patients. There was an independent, significant and positive correlation between dry salted fish, Systolic blood pressure and Non HDL-C, but an independent significant and Non HDL-C in active participants. In all T2DM patients and adjusted for confounders (intake of beef, HC, TG, LDL-C, ApoB, SBP, HOMA-IR, and intake of fried fats), only regular intake of white refined rice and full milk were the most important, independent and significant determinants of high Non HDL-C ≥ 135 mg/dL.

CONCLUSION: Non-HDL-C may be considered as a marker of inflammation, insulin resistance, hypertension, malnutrition, and

atherosclerosis in these Bantu with type 2 diabetes mellitus (T2DM), inappropriate diet, lifestyle changes, and Westernization. Nutritional education and physical activity are recommended in T2DM Central Africans facing health transitions.

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Key words: Non-High density cholesterol; Type 2 diabetes mellitus; Atherosclerosis; Diet; Central Africa

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INTRODUCTION

Cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM) are established as leading causes of morbidity, disability mortality in health care expressed worldwide^[1-3].

Epidemiologic studies consider dyslipidemia (low density lipoprotein cholesterol or LDL-C, elevated levels of triglycerides or TG, and low levels of high density lipoprotein cholesterol or HDL-C, and increased total (cholesterol or TC) as one of the major risk factors of CVD among T2DM patients^[4].

However in few CVD Caucasian patients^[5] and among all CVD Black Bantu (Central Africa) patients, have unusual risk factors for coronary heart disease account or only 25-50% of increase in atherosclerosis risk in diabetic and non diabetic patients^[5-7]. Chemistries explain difficult interpreting the lipid profile in general^[6].

In Bantu Central Africans in particular, the lipid profile is in the normal range or lower levels of TC and TG, whereas there is also a significant U-shaped relationship between cardiometabolic risk and HDL-C stratification (low <40 mg/dL or <1.034 mmol/L, intermediate $40-74.9$ mg/dL or $1.03-1.28$ /mmol/L and high ≥ 75 mg/dL or ≥ 1.29 mmol/L)^[7-9].

T2DM and phenotypic dyslipidemia in Central Africans may be the result of the complex interaction between ethnicity (inherited

characteristics), health (epidemiologic, demographic and nurture) transitions, lifestyle changes (cigarette smoking, excessive alcohol intake, high consumption of carbohydrate fat and salt) and environmental factors (diet, insufficient control of T2DM)^[10].

In Western Africa, at-risk lipoprotein cholesterol (low-HDL-C) is associated with either underweight or overweight^[11], obesity and with poor micronutrient intake^[11].

One of the refinements from American literature, Non-HDL-C (TC-HDL-C) may be an important correlate of atherosclerosis in general and diabetics in particular^[6,12,13].

Therefore it is urgent to obtain the best cut-off point of Non-HDL-C to discriminate presence and absence of at-high CVD risk defined by the combination of T2D (equivalent of coronary artery disease^[14]) and physical inactivity which is significantly associated with Insulin resistance^[15] and type 2 diabetics mellitus (T2DM) among Central Africans. Local data on fish are also absent. The objective of this study was to define non-HDL-C and to access its relationship with CVD risk factors in Black Bantu Central African T2DM patients with glycemic control.

MATERIALS AND METHODS

This cross-sectional survey was conducted at Lomo Medical Clinic, Kinshasa, capital and megacity of Democratic Republic of the Congo (DRC), between November 1st 2007 and December 30th, 2008.

The study protocol was approved by the Institutional Board Research of Lomo Medical Clinic. Informed and signed consent was obtained from individuals to participate to the study which was performed according to the Helsinki Declaration. The systematic random included T2DM patient present first at weekly consultation.

The exclusion criteria were uncontrolled T2D, uncontrolled arterial hypertension drugs for dyslipidemia, thyroid disease, chronic diseases, fever or pregnancy for woman.

Data collection

The investigators received four weeks of training. Patients were interviewed by investigators who collected information on sociodemographic characteristics (sex, age and socioeconomic status or SES), lifestyle/health behavior (physical activity status, cigarette smoking and alcohol intake) and diagnosis known and confirmed T2DM, using a structured and standardized questionnaire.

A trained nurse measured body weight using standard scale to the nearest 0.1kg (Soenle-Waagen GmbH Co., Murrhardt, Germany) after the participants had removed all heavy clothing and shoes. The nurse measured height to the nearest 1cm while each participant stood without shoes using standardized stadiometer. Body mass index (BMI) was obtained in dividing height (kg) by height square in m², Waist circumference (WC) was measured at umbilicus level in mid-expiration to the nearest 0.1cm, while hip circumference (HC) was measured at the nearest 0.1cm using a soft non-elastic measuring tape.

Blood pressure (systolic and diastolic) was measured using an automated sphygmomanometer (OMRON M7; Intelle/Sense, Kyoto, Japan) after participants were tested in a seated position, and this mean of three repeated measurements were recorded.

Laboratory data

For biochemical measures of blood samples taken after a 8-12 h overnight fast, glucose, hemoglobin glycosylated A1c (HbA1c) insulin C-reactive protein (CRP), lipids (triglycerides or TG, total cholesterol (or TC) and lipoproteins (low density lipoprotein cholesterol or LDL-C, high density lipoprotein cholesterol or HDL-C),

apolipoprotein-B (ApoB) profiles were assayed using standards and routine methods at LOMO MEDICAL Laboratory, Kinshasa, DR Congo.

Dietary Intakes

We recorded food diaries specifically developing a quantitative food frequency questionnaire (4-day food diaries with 3 week days and 1 weekend day) Portion sizes, number or volumes were estimated using a photographic album. This standardized and structured questionnaire was used by a nutritionist who also checked and validated dietary records.

Thus rice, bread, cassava (*Manihot esculenta*) bread (Kwanga), fried refined vegetable oil, milk full cream, red meat/beef, fresh fish, dry salted fish, smoked fish, yam, *Gnetum Africanum* (Fumbwa), *Amaranthus hybridus* (Biteku Teku), avocado, pineapple, Papaya, peanut sauce, red palm oil, *Solanum aethiopicum* (Solo), beer, and red wine, were documented during the previous 72 hours.

Definitions

T2DM was known by participants and their physicians and under glucose-lowering medication use in the last 4 weeks, as well as controlled by testing plasma glucose <7 mmol/L (<126 mg/dL) and HbA1c<7%^[16].

The atherogenicity markers were characterized by TC/HDL-C, TG/DHL-C, and LDL-C/HDL-C ratios.

Homeostatic model assessment index for insulin resistance (HOMA-IR) was computed as follows: insulin (m/v/L) × glucose (mmol/L)/22.5^[17].

Statistical analysis

Continuous variables were presented as mean±standard deviation (SD) compared between 2 groups using Student-t test and between ≥3 groups using One-way ANOVA (variables were checked for normal distribution with Shapiro- Wilk test).

Categorical variables were expressed as frequency (*n*=count) and proportions (%) compared between groups using Chi-square test.

Multiple linear regression was used to explore correlations between the variations of continuous levels of Non-HDL-C (dependent variable) and the rest of continuous variables (independent variables) after adjusting for confounding factors with adjusted R² (determination coefficient=variations) to define the strength of associations between continuous variables.

The effective and most optimal cut-off value of Non-HDL-C at discriminating presence (highest value=dependent variable) and absence of physical inactivity using the receiver operating characteristic curve (ROC) method (diagnostic performance defined by the area under the curve or AUC with its 95% confidence interval or 95% CI, standard error).

Forward stepwise was used to perform binary logistic regression, where the highest values of Non-HDL-C was independently associated (odds ratio=OR its 95%CI) with important determinants. *P*-value<0.05 was considered as the definition of statistical significance. Statistical Package for Social Sciences (SPSS) version 21 for Windows (SPSS Inc, Chicago, IL, USA) was used for all analysis).

RESULTS

Out of 720 patients with controlled T2DM, 59.7% (*n*=430) and 52.8% (*n*=380) were females (sex ratio=43women: 29men=1.5-2 women: 1 man) and physically inactive.

The majority of the participants were characterized by the intakes

of starchy Fufu flour, bread, red meat, beet, salted dry fish, leafy vegetables, full milk and smoked fish and fruits were described in the study population (Table 1).

The mean levels of TC, TG, LDL-C, HDL-C, Non HDL-C, beer, ApoB, HOMA-IR, CRP and cigarettes were significantly higher in inactive than active participants, while the mean volumes of red wine was significantly lower among inactive than active participants (Table 2).

In inactive patients, there was significant and positive correlation between amounts of age, HC, TC, Bread, Solanum nigrum, palm oil, beet, SBP, DBP, cigarettes, fried vegetable oils, full milk, bread and values of Non HDL-C, but a significant and negative correlation between the values of BMI, red wine, Ananas Comosus and levels of Non HDL-C, confounding factors (results not shown). In active patients, there was a significant a positive correlation between the amounts of cigarettes, bread, palm oil, full milk and values of Non HDL-C (confounders, results not shown).

After adjusting for confounders in multiple linear regression Model 1, only LDL-C, TG and dry salted fish were significantly and positively correlated with HD2-among inactive patients (Table 3).

Table 1 General Characteristics of the study population.

Variables	n	%
Energetic foods (Carbohydrates)		
Starchy Fufu Flour	630	87.5
Bread	620	86.1
White refined rice	120	16.7
Animal Proteins		
Red meat/Beef	580	80.6
Salted Dry Fish	580	75
Smoked Fish	270	37.5
Full milk	290	40.3
Fresh Fish	110	5.3
Chicken	110	15.3
Plants/Tubers, Vegetables and Fruits		
Solanum aethiopicum	440	61.1
Amaranthus Hybridus	290	40.3
Gnetum Africanum	230	31.9
Yam	100	13.9
Carica Papaya	120	16.7
Parsea Americana	70	9.7
Ananas Comosus	60	8.3

Table 2 Mean levels of some continuous variables by the level of physical activity (Physical inactivity for $n=380$ vs physical activity for $n=340$).

Variables	Inactive mean \pm SD	Active mean \pm SD	P value
TC (mg/dL)	239.4 \pm 54.6	51.5 \pm 50.4	<0.00001
TG (mg/dL)	196.4 \pm 80.7	109.4 \pm 26.8	<0.00001
HDL-C (mg/dL)	94.8 \pm 53	48.4 \pm 34	<0.00001
Non HDL-C (mg/dL)	144.6 \pm 27.4	103 \pm 22.8	<0.00001
Red Wine (mL/72 h)	319 \pm 439.4	769.4 \pm 427.2	<0.00001
Beef (mL/72hours)	285 \pm 504.6	50.3 \pm 130.8	<0.00001
ApoB 100 (mg/dL)	165.7 \pm 27	124.7 \pm 22.5	<0.00001
CRP (mg/dL)	8.4 \pm 4.7	4.3 \pm 3	<0.00001
HOMA-IR	8.3 \pm 1	7 \pm 1.1	<0.00001
Cigarettes (n/72 h)	13 \pm 22.4	4.4 \pm 15.1	<0.00001

Table 3 Independent determinant of variations of Non HL among physically inactive patients (Multiple linear regression Model 1).

Independent variables	Unstandardized coefficients		Standardized coefficients	
	B	S.E	Beta	P value
Constant	-7.372	13.957		0.601
LDL-C	0.816	0.062	0.820	<0.0001
Triglycerides	0.270	0.064	0.264	<0.0001
Dry salted fish	7.303	3.536	0.126	0.047

$R^2 = 88\%$

However, after adjusting for confounding factors using multiple linear regression Model 2, there was an independent, significant and positive correlation between dry salted fish SBP and Non HDL-C, but an independent significant and Non HDL-C in active participants (Table 4).

Table 4 Independent determinants of variations of Non HDL among physically active patients (Multiple Linear regression Mode 2).

Independent variables	Unstandardized coefficients		Standardized coefficients	
	B	S.E	Beta	P value
Constant	-69.336	46.920		0.150
Dry salted fish	34.510	7.164	0.587	<0.0001
SBP	1.468	0.373	0.605	<0.0001
BMI	-3.317	1.070	-0.478	0.004

$R^2 = 88\%$

In not entering LDL-C and TG within multivariate linear regression Model 3 and after adjusting for confounders in all only SBP was independently, significantly and positively correlated with Non HDL-C but amount s of Cassava bread were independently significantly negatively correlated with Non HDL-C ≥ 135 mg/dL in inactive patients as follows: Y (adjusted $R^2=30\%$)= $64.1+0.334 \times SBP -0.327 \times$ regular intake (yes=1, No=0) Cassava bread.

The ROC method determined Non HDL-C ≥ 135 mg/dL as the optimal cut-off point to discriminate physical inactivity and physical activity with the following diagnostic performance pattern: Sensitivity=70 %, Specificity=88.2 %, AUC=0.876 95% CI 0.800-0.953; standard error=0.039; $P<0.000$.

Lower volume of red wine intake, but higher values of HC, TG, LDL-C, ApoB, SBP, DBP, and HOMA-IR were observed in high Non HDL-C ≥ 135 mg/dL group in comparison with those in normal Non HDL-C<135 mg/dL group, difference being statistically significant (Table 5).

Table 5 Significant variations of some cardiometabolic factors by Non HDL status.

Variables	High Non HDL ≥ 135 mg/dL mean \pm SD $n=28$	Normal Non HDL <135mg/dL mean \pm SD $n=44$	P value
HC (cm)	102.5 \pm 11.3	95.1 \pm 9.2	<0.001
TG (mg/dL)	189.6 \pm 43.5	111.3 \pm 57.1	<0.00001
LDL-C (mg/dL)	125.3 \pm 19.7	82.3 \pm 15.4	<0.00001
ApoB 100 (mg/dL)	180.1 \pm 17.6	124.8 \pm 17.5	<0.00001
SBP (mmHg)	157.1 \pm 12.1	148.5 \pm 9.8	<0.001
DBP (mmHg)	102.5 \pm 11.3	95.1 \pm 7.2	<0.001
HOMA-IR	8.1 \pm 1.1	7.5 \pm 0.8	0.014
Red Wine (mL/72hours)	377.1 \pm 437.5	630 \pm 495.1	0.031

Higher and significantly univariate risk for high Non HDL-C ≥ 135 mg/dL was conferred by regular intake of white refined rice (66.7 %, OR=4 95% CI 1.1-15, $n=80/120$, Yes vs 33.3% $n=200/600$ no; $P=0.031$), full milk regular intake (55.2 %, OR=3.2 95% CI 1.2-8.6 vs 27.9 % $n=120/430$ no; $P=0.20$), beef intake (44.8 %, OR=4.9 95% CI 1-23.7, $n=260/580$ yes vs 14.3 % $n=20/140$ no; $P=0.035$), intake of fried fats (50% $n=30/460$, OR=4.2 95% CI 1.4 -13.1 vs 19.2 % $n=50/260$ no; $P<0.01$) and high Non HDL-C ≥ 135 mg/dL.

In all T2DM patients and adjusted for confounders (intake of beef, HC, TG, LDL-C, ApoB, SBP, HOMA-IR, and intake of fried fats), only regular intake of white refined rice and full milk were the most important, independent and significant determinants of high Non HDL-C ≥ 135 mg/dL (Table 6).

Table 6 Independent determinants of Non HDL \geq 135 mg/dL in All.

	B	S.E	Wald	OR(95%CI)	P value
Independent variables					
Refined Rice Intake, Yes	2.296	0.780	8.666	9.9 (2.2-45.8)	0.003
Refined Rice Intake, No	Reference 1				
Full Milk Intake, Yes	1.860	0.611	9.257	6.4 (1.9-21.3)	0.002
Full Milk Intake, No	Reference 1				
Constant	-1.705	0.486	12.314		<0.0001

DISCUSSION

Despite control, glycemic control, the present study characterized variables associated with an unmet need in finding, diagnosing, and preventing CVD using a simple measure among T2DM Central Africans. The present study demonstrated an absence of a central part of the treatment of high risk people facing different transitions after rural urban migration.

This paper was a contribution to characterize the variations of non HDL-C which may be a more powerful risk factor of CVD and its risk factors (independent determinants) not only in Bantu Ethnic group but in other American ethnic groups^[5-7,12,13,18-23].

Univariate analyses were able to identify potential factors associated with higher concentration of non - HDL-C, while multivariate determined significantly independent determinants of higher non-HDL-C by physical activity status. Both multiple linear regression and binary logistic regression models were used to avoid collinearity between variables and adjusting for confounders.

Non-HDL-C computed by subtracting the so called food HDL-C from the TC and introduced in ATPIII^[22], was, at our first occasion confirmed as an important marker of physical inactivity, atherosclerosis, insulin resistance, inflammation, high blood pressure, and inappropriate diet among these T2DM black Bantu from Central African region.

Despite controlled levels of glycemia, these T2DM patients were at high risk of CVD because health (epidemiology, demographic, nutrition) transitions, urbanization-related lifestyle changes, uncontrolled hypertension, and lack of lowering-TC, TG, and LDL-C. There was suggested an interaction between genetics (ethnicity, non modifiable age) and environmental factors sometimes with inverse epidemiology in a phenotypic dyslipidemia and moderate intake of red wine for Bantu.

Health Transitions

Traditional diet (Fufu flour, yam, vegetables) was coexisting with Westernized diet (Bread, red meat, Full milk, fried fats) and lifestyle changes (physical inactivity and cigarette smoking) with high proportions among these T2DM patients.

Directions of the variations of non- HDL-C

The pathophysiological variations of present non- DL-C were neutral (constant or 0), negative (decrease), and positive (increase) in all, physically inactive, and physically active Bantu T2DM patients, respectively.

Neutral directions of non-HDL-C

The present effects of gender, SES, WC, and intake of some foods (fresh fish, yam, palm oil, Gnetum Africanum, Amaranthus hybridus, Carica Papaya, Parsea Americana, Ananas Comosus, and chicken were indifferent on the variations of non-HDL-C in all T2DM patients.

The uniform diet patterns may be explained by the rural to urban migration (theory of the niche): concurrent consumption of traditional

foods (Gnetum Africanum) and imported chicken at the nurture transition.

The low intake of fruits because of cultural beliefs in Africans^[24] and perceptions in diabetics, attempted to demonstrate a protective effect, (OR<1) with P-values between 0.06 and 0.09.

Very high levels of HDL-C \geq 75 mg/dL is known to be related negatively to abdominal obesity / insulin resistance (WC \geq 94 cm) in male Central Africans with ischemic heart disease^[25].

A new discipline, clinical nutrition, inspired by Institute of Medicine Dietary^[26], should be developed with both quantitative and dichotomic approaches to assess the associations between traditional CVD risk factors, novel markers, dietary patterns, and the variations of non-HDL-C.

Therefore, the non-HDL-C levels should be decreased in case of TC- increase in HDL-C among these Central Africans T2DM patients without significant association with WC levels.

Positive directions of non-HDL-C

The present study showed a univariate and significant positive gradient biologic between HC (peripheral obesity), intake of beer, smoked fish, Blood pressure (SBP DP), lipid – lipoprotein profile (TG, LDL-C, ApoB), HOMA-IR, and increase in non DL-C among all T2DM patients. Physically inactive T2DM patients had highest amounts of TC, TG, LDL-C, non-HDL-C, beer, ApoB, HOMA-IR, CRP, and cigarettes in comparison with levels from their active T2DM patients.

When inactive T2DM patients were only considered, there was a significant and positive association between highest values of age, HC, TC, intake of bread, Solanum nigrum, palm oil, beer, SBP, DBP, and highest levels of non-HDL-C. After adjusting later univariate correlates in all, only regular intake of white refined rice (10 times risk) and full milk (6 times) independently and significantly contributed higher risk (OR) of elevated non-HDL-C.

Moreover, the proportion increase in non-HDL-C concentrations varied according to the physical activity status in this study. Higher amounts of intake of dry salted fish (imported) were associated significantly and independently related to increased levels of non – HDL-C in both inactive and active T2DM patients. In active T2DM patients, the values of LDL-C and TG explained also independent variations of the concentration of non – HDL-C.

In active T2DM patients, only higher levels of SBP were related significantly and independently associated with increasing concentrations non-HDL-C.

Negative directions of non-HDL-C

Paradoxically, in these T2DM patients, the values of HDL-C (a component of non- HDL-C) were significantly higher in physically inactive than physically active participants. The amounts of Fufu Flour and red wine consumption were significantly lower in T2DM patients with non – HDL-C \geq 135 mg/dL than their counterparts with non-HDL-C < 135 mg/dL.

There was also a negative and significant association between decrease in BMI and increase in non-HDL-C independently of univariate associated factors among active T2DM patients. However, there was a negative, significant and independent association between intake of Cassava bread (protection) and decrease in non-HDL-C among inactive T2DM patients.

Clinical implications and perspectives for Public Health

This study will impact significantly in the understanding of the pathophysiology of non-HDL-C and the changes for Practice

Guidelines to improve the quality of clinical practice and T2DM patients in Central African Region.

It is urgent for Central African policy makers, investigators, and health professionals to deal with multidisciplinary and interprofessional approaches with Evidence-Based Medicine at establishing recommendations an education for African T2DM patients as proposed by American facts.

Researchers should be aware that the interactions between genetics (Bantu ethnic group, non-modifiable aging, heredity of T2DM) and environmental factors (no prescribing statins, rare intake of fruits, high intake of salt, polysaturated fats, and refined cereals in nutrition transition, urbanization, and physical inactivity).

Non-HDL-C, a cheap marker that can be easily calculated in any primary health care system from sub-Saharan Africa, will be beneficial as follows: direct measure of TC and HDL-C (TC-HDL-C), no consideration of normal lipoprotein composition, no need of fasting specimen, reflection of the sum of cholesterol carried by LDL, very low density lipoprotein (VLDL), intermediate density lipoprotein, and remnant lipoproteins (well established potentially atherogenic lipoproteins^[27]). Despite the complexity of the pathobiology of non-HDL-C in these Bantu Central T2DM patients, the findings suggested synergistic effects between non-HDL-C disorders and low-grade inflammation markers (CRP, lower BMI, higher HC)-oxidative stress markers (cigarette smoking, aging, intake of fried vegetable oil) might accelerate atherosclerosis in T2DM which is an equivalent of coronary artery disease. Indeed, atherosclerosis is now known as an inflammatory condition^[28].

In T2DM with hyperglycemia-related oxidative stress, overproduction of oxygen free-radical precursors decreases the antioxidant system^[29].

Furthermore, clinicians will engage on diabetic dyslipidemia for secondary prevention of CVD among T2DM patients at demographic transition (aging) adopting a new guideline for cholesterol management according to the recent systematic evidence from the joint of the American College of Cardiology and the American Heart Association (ACC/AHA)^[30]. From this American Expert panel, there is no longer evidence supporting use of fixed LDL or non-HDL-C goals at identifying patients groups from moderate or high intensity statin therapy^[30].

Health professionals could educate and prescribe dietary patterns (not individual food, but combination of different foods)^[30] rich in antioxidants (red wine, cassava) and fiber (Gnetum Africanum), exercise, and smoking cessation.

Evidence supports improvement of hemorheological parameters in moderate red wine intake by healthy individuals^[31].

A polyphenol such as Resveratrol plays with antioxidants (from red wine), anti-inflammatory, and anti-proliferative, and anti-angiogenic effects^[32,33].

On the contrary, excessive intake of alcohol such as beer (hypercaloric and obesogenic).

Diversified eating of combined foods such as cassava (tapioca) with Cassava leaves reducing risk of metabolic syndrome in Central Africans T2DM patients^[24], moderate intake of red wine, and fresh fish could be promoted. Indeed, a high fat diet of hydroxypropyl tapioca starch retards the development of insulin resistance in diabetic mice^[34]. Cassava bread supplementation does not increase significantly the energy content of the diet and does not modify plasma lipid levels in rats^[35].

Limitations

The cross-sectional approach may be a limitation to some degree in

this study. A future longitudinal prospective study should be able to demonstrate a causal association between the identified determinants of the increase in the concentrations of non-HDL-C among T2DM patients.

An important limitation of this study was that a higher number of determinants of increase in non-HDL-C was unknown (only 50% of the variations of non-HDL-C) in active T2DM patients in comparison with almost 90% of the variations of non-HDL-C explained among inactive T2DM patients.

CONCLUSION

These Central African T2DM patients were defined by abdominal obesity (100%) insulin resistance (100%), and post-phase of rare nutrition transition, rare consumption of fruits, exclusive tight glycemic control (100%), and never treated with statin (100%).

Non-HDL-C may be considered as a marker of inflammation, insulin resistance, hypertension, malnutrition, and atherosclerosis.

Moderate Intake of red wine and Cassava bread may reduce atherogenic capacity of non-HDL-C, while exaggerated intake of refined rice, full milk, fried fats, salted dry fish, beer, and red meat, as well traditional CVD risk factors increase the risk of higher level of non-HDL-C.

CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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