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Nutrition Transition, Malnutrition and Cardiometabolic Risk Factors in the Far North Region of Cameroon

Françoise Raïssa Ntentie[1,2*], Maxwell Wandji Nguedjo[2,3], Jacob Tchinda Nkougni[2], Huiny Miriane Fotso Tienou[2], Inelle Makamwe[2], Gerald Dama[4], Boris Ronald Tonou Tchuente[2,3], Mary-Ann Angie Mbong[2], Christine Fernande Biyegue Nyangono[2,5], Enyong Julius Oben[2]

1. Department of Biological Science, Higher Teachers' Training College, University of Yaounde 1, Yaounde-Cameroon
2. Laboratory of Nutrition and Nutritional Biochemistry, Department of Biochemistry, Faculty of Sciences, University of Yaounde 1, Yaounde-Cameroon
3. Centre for Food, Food Security and Nutrition Research, Institute of Medical Research and Medicinal Plant Studies, MINRESI, Yaounde, Cameroon
4. Department of Life and Earth Science, Higher Teachers' Training College, University of Maroua, Maroua, Cameroon
5. Higher Teachers' Training School for Technical Education, University of Douala, Douala, Cameroon

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**Corresponding author:*
Françoise Raïssa Ntentie, PhD;
Department of Biological Science, Higher Teachers' Training College, University of Yaounde 1, Yaounde-Cameroon.
Tel: +237-693617074
Email: franc_ntentie@yahoo.fr
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ABSTRACT

Background: The increased prevalence of cardiovascular diseases observed worldwide is linked to nutrition transition This study assessed the level of nutritional transition and its implications in the occurrence of cardiometabolic risk factors among populations living in the Far North Region of Cameroon.

Methods: A cross-sectional, descriptive, and analytical study was conducted in November 2020 recruiting 350 Cameroonians of both genders aged 18 years and above in urban (Maroua), semi-urban (Kaele) and rural (Midjivin) areas. Demographic, socioeconomic status and food habits were assessed through an interview. Anthropometry (weight, height, body mass index: BMI) and blood pressure were measured. A fasting blood sample was collected for lipid profile.

Results: Mean age was higher in Kaele (44.99±16.55 years) and Midjivin (47.23±18.21 years). Urban residents of Maroua (23.38±4.80 kg/m^2) and Kaele (23.13±5.01 kg/m^2) had the highest BMI. Rural dwellers exhibited elevated cholesterol (220.30±70.40 mg/dL) and triglycerides (120.52±62.64 mg/dL). Diastolic blood pressure and heart rate increased significantly with urbanization. Low fruit and vegetable consumption, high alcohol intake, and low physical activity were observed in all three areas. An increased frequency of abdominal obesity, high blood pressure, hypercholesterolemia and hypertriglyceridemia were noticed among all participants . Midjivin inhabitants showed behavioral changes closer to those in Maroua, while those living at Kaele had a slower rate of nutrition transition.

Conclusion: People living in rural, semi-urban, and urban areas have started the nutrition transition process in this part of the country. Thus nutritional education needs to be reinforced for a better prevention of nutritional-related morbidities and mortalities drived by urbanization.

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Introduction

Cardiovascular diseases (CVDs) are the leading cause of premature mortality, and morbidity, with approximately 17.9 million deaths worldwide (1) and 80% in lower-income countries (2), where infectious diseases and global nutritional deficiencies persist (3). The Sub-Saharan African countries are not spared. The nutrition transition is closely related to demographic and epidemiological transitions (4). Industrial and technological developments play a crucial role in lifestyle changes among the population, making them more westernized in their food habits, a major determinant of the nutrition transition (5). The ongoing nutrition transition increased CVD risk factors (overweight/obesity, hypertension, type 2 diabetes, and dyslipidemia) (6).

In recent decades, authorities made efforts to encourage the adoption of healthier and sustainable food choices and dieting in most developed countries (7), and some populations can be classified to be at the stage of awareness and adoption of a healthy lifestyle (5). Unfortunately, in many African countries, efforts are still made to their development and health; but awareness on changes brought by modernization is far-fetched. These countries experienced the fastest rate of urbanization (perceptible through its rapid demographic and epidemiological transitions) and faced rapid increased consumption of ultra-processed foods and beverages. They inevitably reached the same levels as those of high-income countries, with all the negative impacts on health (8); such as the increased prevalence of nutrition-related chronic diseases that are projected to exceed infectious diseases by 2030 (9).

Cameroon undoubtedly seems to face the same situation and the main outcome is the increased prevalence of non-communicable diseases and the persistence of nutritional deficiency (10). Studies evaluating indicators of nutrition transition have been based mostly in the Southern part of the countries in the detriment of the Northern part (9). The studies deployed in this part of the country focused mainly on nutritional deficiencies, while these populations also faced a nutrition transition marked by the rise of so-called emerging or societal diseases. Pilot studies conducted outside the hospital setting confirmed the evolution of these pathologies in a locality in the Far North Region (11, 12). Thus, a more in-depth study of the indicators and determinants of the nutrition transition is necessary for this part of the country. So the present study aimed at evaluating the indicators of the degree of urbanization of the study sites considering the rural-urban gradient; in addition to assessing dietary habits and lifestyle according to the degree of urbanization of the population; and finally investigating cardiovascular risk factors according to the degree of urbanization among some populations residing in three areas in the Far North Region of Cameroon.

Materials and Methods

From the 3rd to the 13th of November 2020, participants were randomly recuited during mass health campaigns in Maroua (Diamaré Division); Kaele (Mayo-Kani Division); and Midjivin (a village of the Mayo-Kani Division) in the Far-North Region of Cameroon. The Far North Region, located between 11°30'20'' North latitude and 14°33'60'' East longitude, is situated in the northern part of Cameroon, bordering Chad and Nigeria. Beyond its cultural and ethnic diversity, several ethnic groups, including the Guiziga, Peulh, Moundang, Toupouri, Mandara, Mafa are represented. Agriculture, the main source of income, is dominated by food crops such as cereals, vegetables, and cash crops such as cotton, peanuts, and onions. It is the region with the highest level of poverty (13).

Cameroonian-born women and men, aged 20-70 years who have lived in the study place for at least one year and who gave their informed consent, were enrolled. Pregnant or lactating women and people with physical and mental disabilities were excluded from the study. The sample size was computed using the Magnani formula (14). The 95% confidence level, 5% margin of error and 31% prevalence of overweight among Cameroonians were applied (10). The minimum required sample size was 350. A well-structured questionnaire conceived from the WHO STEPWISE instrument was administered by a well-trained surveyor. Data on age, gender, area of residence, marital status, profession, level of education, household ownership, physical activity, tobacco and alcohol use, etc... were collected through face-to-face interviews at survey sites (health districts, health centres, palace places, etc...). French and the local dialect were the languages used.

This study was approved by the National Ethics Committee of Research for Human Health of Cameroon (N°2014/08/488/CE/CNERSH/SP). Administrative research authorizations from the Far North Regional Delegate of Public Health and the heads of health districts of Maroua and Kaele were obtained before sampling. Consent was obtained after the objectives, and the minimal risks and benefits of the study were well explained to each participant to whom a code was attributed for confidentiality.

Dietary habits were assessed by collecting information on the frequency of consumption

of various food groups using a food frequency questionnaire (FFQ). The FFQ included different food items consumed throughout the year by the population of the Far-North Region (traditional diets, imported cereals and locally made cereals, tubers, meat, fish, eggs, poultry, dairy products, fruits, vegetables, fats and oils, snacks, beverages, alcoholic drinks; sweet drinks; tea, etc...) (14). The questionnaire was designed to consider all foods/beverages typically consumed, including traditional foods not available in stores and those available seasonally.

Data were collected on the number of days in the past 7 days a participant ate specific food items. The obtained data were classified for the frequency of consumption of participants into 3 categories of 0-1 time per week as low consumption; 2-3 times per week as moderate consumption and 4-7 times per week as high consumption. Subsequently, the various foods were then grouped into eight food items (cereals and tubers; pulses and beans; milk and dairy products; meat, fish, and eggs; vegetables; fruit; oil; sugar and derivatives) (15, 16) for the calculation of the food consumption score (FCS) using the following formula where X=number of days of consumption of each food group during the past 7 days; and a=weight assigned to the food group. FCS was reported on a scale with standard thresholds used to determine the three categories of food consumption. FCS from 0 to 28 referred to low food consumption; FCS between 28.5 and 42 referred to limited food consumption and FCS>42 was considered as acceptable food consumption (17).

$$FCS = a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8$$

Also, a 24-hour recall of dietary consumption (day, week) was recorded. Each participant was asked to mention everything he/she had eaten the day before the survey (from wake up in the morning to sleep in the night). The collected data helped to construct the dietary diversity score (DDS). The participants were grouped into 3 categories according to their DDS as poorly diversified diet (DDS between 0-3); moderately-diversified diet (DDS between 4-5) and diversified diet (DDS of 6-10) (18, 19).

The weight was recorded to the nearest 0.1 kg using an electronic balance (The Tanita™ BC 418 Segmental Body Composition Analyzer/Scale) with participants wearing light clothing. Height was measured with a Harpended™ stadiometer to the nearest 0.1 cm. Body mass index (BMI) was computed and categorized as follows: Underweight: BMI<18.5 kg/m^2; normal weight: BMI=18.5-24.9 kg/m^2; overweight: BMI=25.0-29.9 kg/m^2; and obese: BMI≥30.0 kg/m^2. Waist circumference (WC) measurements to the nearest 0.1 cm, were assessed with flexible but non-stretchable tapes measured according to WHO guidelines, at the midpoint between the last rib and the iliac crest. Blood pressure (BP) was measured two times using a mercury sphygmomanometer (Life source™). The first one after a ten minutes rest at the seating position and the second one, 5 minutes later. The BP values were the mean of the two measurements. Elevated BP was defined as systolic blood pressure (SBP)≥140 mmHg and/or diastolic blood pressure (DBP)≥90 mmHg (20).

Approximately 5 mL of a 12-hour overnight fasted venous blood were collected, then centrifuged for 10 minutes at 1000 g at 4°C, 1 mL aliquot of serum was pipetted into labelled cryovials and immediately stored at −70°C for biochemical evaluation. Serum total cholesterol (TC) (21) and triglycerides (TG) (22) levels were assessed with standard enzymatic spectrophotometric methods. High total cholesterol (TC) cut-off value was TC≥2 g/L and hypertriglyceridemia (HyperTG) was defined as triglycerides≥1.5 g/L (23). IDF criteria were used to diagnose metabolic abnormalities as follows: Abdominal obesity was diagnosed with waist circumference≥80 cm for women and ≥94 cm for men. Fasting triglycerides≥1.5 g/L or triglycerides lowering drugs treatment referred to a hypertriglyceridemia state, while fasting total cholesterol≥2g/L referred to total hypercholesterolemia. A systolic blood pressure (SBP)≥130 mmHg and/or diastolic blood pressure (DBP)≥85 mmHg, or hypotensive treatment referred to high blood pressure (24).

Data were analysed using the IBM SPSS statistical software package (Version 20.0, Chicago, IL, USA). Results were expressed as means with standard deviation (SD) for continuous variables or as percentages for categorical variables. Categorical variables were compared by the Chi-Square test and continuous variables were compared by one-way analysis of variance (ANOVA) followed by post hoc LSD. The significance was established at $p<0.05$.

Results

Men were more represented in the city of Maroua (64.8%) when compared to the semi-urban area of Kaele and rural area of Midjivin. The illiteracy rate was highest in the rural area of Midjivin (33.3%). Most of the participants had completed secondary school; those with a university degree were more represented in Maroua city. In terms of occupation, 35.8% of the participants in Maroua worked in the informal sector, compared to 27.1% in Kaele;

while in Midjivin, 57.7% of them were farmers. Additionally, 46% (Maroua) to 82.3% (Kaélé) of participants were married; in total, 14.1% and 13.1% were separated/widowed in Midjivin and Maroua, respectively (Table 1).

The mean age was significantly higher in Kaele (44.99±16.55 years) and Midjivin (47.23±18.21 years). BMI was higher among urban populations (Maroua and Kaele), while DBP and HR increased with the degree of urbanization. For lipid profile, total cholesterol and triglycerides were higher among Midjivin inhabitans (p<0.05, Table 1). The exploration of some indicators of the degree of urbanization among the study population were recorded in Table 2, showing that all participants were in search of better living conditions through the acquisition and the use of some modern equipment. As for the source of energy for cooking, a high rate of firewood use was observed in Maroua (81.3%) and Kaele (60.5%). Charcoal was the main energy source (84.6%) in Midjivin compared to Kaele and Maroua; while kerosene, butane gas and other sources were less used. As the roofing material for houses, the high use of metal sheets was noted in Maroua (93.7%) and Kaele (90.6%) compared to Midjivin (47.4%), where about half of the village houses were made of thatch (48.7%). Radio, TV, bicycles, and motorcycles were more used by city dwellers than their rural counterparts. In other words, the rate of acquisition of modern goods was high from rural to urban areas. A low use of refrigerators and cars was noted in Maroua (16.2% and 7.1%) and Midjivin (3.8% and 00%) when compared to Kaele with a higher rate of 19.1% and 11.7%, respectively.

The food habits and lifestyle of the study participants are presented in Table 3. Results show that participants consumed almost all food groups. Cereals and derivatives were the main carbohydrate sources consumed by 87.5% (Maroua) and 94.8% (Kaele) of the participants. They were eaten more than four times a week compared to tubers and derivatives that were less consumed. For animal protein sources, poultry was less consumed in the three areas of the study. A high frequency of consumption of red meat (2-3 times/week) was recorded in Maroua (56.2%), Kaele (56.2%) and and Midjivin (47.4%) respectively. The findings revealed an average frequency of consumption (2-3 times/week) of fish in the different study areas notably 50% in Maroua, 42.7% in Kaele and 44.9% in Midjivin. For proteins of plant origin, pulses were highly consumed (more than 4 times a week) by 54.5%

Table 1: General, anthropometric, clinical and biochemical characteristic of the study population.

Variable		Maroua (n=176)	Kaele (n=96)	Midjivin (n=78)	ANOVA *P* value
Gender	Men, % (n)	64.8 (114)	50 (48)	50 (39)	NA
	Women, % (n)	35.2 (62)	50 (48)	50 (39)	
Level of education	No education, % (n)	17.6 (31)	14.6 (14)	33.3 (26)	NA
	Primary school, % (n)	22.7 (40)	32.3 (31)	26.9 (21)	
	Secondary school, % (n)	46.0 (81)	50 (48)	35.9 (28)	
	University, % (n)	13.7 (24)	3.1 (3)	3.8 (3)	
Profession	Student, % (n)	9.7 (17)	3.1 (3)	2.5 (2)	NA
	No job, % (n)	20.5 (36)	22.9 (21)	6.4 (5)	
	Farmer, % (n)	11.4 (20)	19.8 (19)	57.7 (45)	
	Salaries, % (n)	11.9 (21)	12.5 (13)	15.4 (12)	
	Housewife, % (n)	10.2 (18)	11.5 (11)	3.9 (3)	
	No formal activity, % (n)	35.8 (63)	27.1 (26)	14.1 (11)	
	Retired, % (n)	0.6 (1)	3.1 (3)	0(0)	
Marital status	Single, % (n)	40.9 (72)	15.6 (15)	20.5 (16)	NA
	Maried, % (n)	46.0 (81)	82.3 (79)	65.4 (51)	
	Widow/divoced, % (n)	13.1 (23)	2.0 (2)	14.1 (11)	
Age (years), (mean±SD)		38.65±15.39[a]	44.99±16.55[b]	47.23±18.21[b]	0.0001
Body mass index (kg/m^2), (mean±SD)		23.38±4.80[a]	23.13±5.01[a]	21.70±3.98[b]	0.032
Waist circumference (cm), (mean±SD)		83.22±15.13[a]	80.77±14.68[a]	80.38±10.89[a]	0.224
SBP (mmHg), (mean±SD)		125.44±20.11[a]	126.96±26.43[a]	123.31±23.39[a]	0.585
DBP (mmHg), (mean±SD)		84.28 ±16.38[a]	78.78±17.59[b]	72.77± 15.17[c]	0.0001
Pulse (pool/min), (mean±SD)		86.08±17.42[a]	83.29±17.97[b]	78.04±12.83[c]	0.002
Total cholesterol (mg/dL), (mean±SD)		170.81±78.16[a]	199.60±67.04[b]	220.30±70.40[b]	0.0001
Triglycerides (mg/dL), (mean±SD)		116.53±60.70[a]	91.90±54.61[b]	120.52±62.64[c]	0.002

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; on the same line, values affected with the same letter are not significantly different at p<0.05. NA: non applicable.

Table 2: Assessment of some indicators of the level of urbanization in the areas of study.

Variable		Maroua (n=176)	Kaele (n=96)	Midjivin (n=78)
Source of water	River, % (n)	1.7 (3)	2.1 (2)	0.0 (00)
	Tap, % (n)	47.7 (84)	47.9 (46)	7.7 (6)
	Public Bore hole, % (n)	39.2 (69)	38.6 (37)	65.4 (51)
	Public well, % (n)	10.2 (18)	10.4 (10)	26.9 (21)
	Others, % (n)	1.2 (2)	1.0 (1)	0.0 (00)
Source of cooking energy	Firewood, % (n)	81.3 (143)	60.5 (58)	12.8 (10)
	Charcoal, % (n)	17.0 (30)	37.6 (36)	84.6 (66)
	Kerosene, % (n)	00.0	1.0 (1)	1.3 (1)
	Gas, % (n)	1.7 (3)	1.0 (1)	0.0 (00)
	Others, % (n)	0.0(0)	0.0 (0)	1.3 (1)
Type of building materials	Tile, % (n)	2.9 (5)	1.1 (1)	1.3 (1)
	Metal Sheet, % (n)	93.7 (165)	90.6 (87)	47.4 (37)
	Metal Scrap, % (n)	2.9 (5)	1.1 (1)	2.6 (2)
	Stubble, % (n)	0.5 (1)	5.3 (5)	48.7 (38)
	Others, % (n)	0.0 (00)	2.0 (2)	0.0 (00)
Radio	Yes, % (n)	63.7 (107)	54.3 (51)	28.2 (22)
Television	Yes, % (n)	61.7 (103)	46.8 (44)	11.7 (9)
Refrigerator	Yes, % (n)	16.2 (27)	19.1 (18)	3.8 (3)
Car	Yes, % (n)	7.1 (12)	11.7 (11)	0.0 (00)
Bicycle	Yes, % (n)	40.5 (68)	33.0 (31)	43.6 (34)
Motorcycle	Yes, % (n)	39.9 (67)	35.1 (33)	29.5 (23)

(Maroua) to 59% (Midjivin) of the participants. A low consumption of eggs (0-1 time/week) was observed in Maroua (53.4%), Kaele (59.4%), and Midjivin (61.5%), as well as a low consumption of dairy products (0-1 time/week) in Maroua (51.1%), Kaele (57.3%) and Midjivin (56.4%).

Regarding fruits and leafy vegetables and other vegetables with beneficial cardioprotective properties cleary demonstrated, a low frequency of consumption (0-1 time/week) in the general population was noted. However, there was high consumption of okro (2-3 times/week) by Maroua dwellers (53%) when compared to Kaele (47.9%) and Midjivin (44%) dwellers. Regarding oil and fats consumption, it appeared that the highest frequency of consumption (more than 4 times a week) increased in rural (35.6% in Midjivin) and urban areas (78.8% in Maroua). About 65.6% of the participants added sugar to their meals (0-1 time/week), while 57.4% ate sweet foods. However, a low tendency to snacking was observed (0-1 times/week) among 82.4% (Maroua), 87.5% (Kaélé) and 93.4% (Midjivin,) of the participants. About 43.6% (Maroua) and 24.2% (Kaélé) of the dwellers tended to eat meals away from their homes. For soft drinks, which are important and additional sources of energy, 56.8% (Maroua), 64.6% (Kaélé), and 65.8% (Midjivin) of the participants consumed them at least once a week (Table 3).

The dietary diversity score (DDS) was significantly higher in Maroua and Midjivin when compared to Kaele, while, the food consumption score (FCS) increased with the rural-urban gradient (50.09±20.12; 63.21±26.1; 70.99±24.16, Table 4). Figure 1 shows that 50% (Midjivin) and 54.8% (Maroua) of the participants had a moderately diversified diet. However, the proportion of participants with a diversified diet was higher in Maroua (12.3%) and Kaele when compared to Midjivin (4.2%) participants. A high predominance of acceptable FCS was remarkable in all three localities of the study (Figure 2). However, it is important to note that the number of participants with low FCS was recorded in urban areas (Maroua and Kaele). Participants with borderline FCS were noticed in Maroua (17.9%) and Midjivin (15.4%).

It appears from Table 5 that in all population, the total hypercholesterolemia (41.9%) and elevated BP (41.5%) were the most frequent cardiometabolic risk factors. According to the study area, total hypercholesterolemia was significantly high among Maroua residents (50.9%) when compared to Kaele (31.3%) and Midjivin (33.3%) areas. Elevated blood pressure was more frequent in the rural area (43.8%) and Maroua (41.7%) when compared to Kaele (39.4%). Maroua and Kaele populations were the most affected by cardiometabolic risk factors in comparison to Midjivin population. Abdominal fat accumulation was more frequent in Maroua followed by Midjivin. Regarding the cumulative presence of risk factors, 42.7% of Kaele dwellers presented one

Table 3: Evaluation of the food consumption and some food habits.

Variable	Frequency of consumption	Maroua (n=176)	Kaele (n=96)	Midjivin (n=78)
Cereals and derivates, % (n)	0-1 time/week	0.6 (01)	0 (0)	1.3 (01)
	2-3 times/week	11.9 (21)	5.2 (05)	10.3 (09)
	≥4 times/week	87.5 (154)	94.8 (91)	88.4 (69)
Tubers and derivates, % (n)	0-1 time/week	27.3 (48)	11.48 (11)	24.4 (19)
	2-3 times/week	63.6 (112)	57.3 (55)	62.8 (49)
	≥4 times/week	9.1 (16)	31.3 (30)	12.8 (10)
Pulses, % (n)	0-1 time/week	6.8 (12)	1.0 (01)	3.8 (03)
	2-3 times/week	38.7 (68)	48.0 (46)	37.2 (29)
	≥4 times/week	54.5 (96)	51.0 (49)	59.0 (46)
Red meat, % (n)	0-1 time/week	16.5 (29)	25.0 (24)	21.8 (17)
	2-3 times/week	56.2 (99)	56.2 (54)	47.4 (37)
	≥4 times/week	27.3 (48)	18.8 (18)	30.8 (24)
Fish, % (n)	0-1 time/week	22.2 (39)	29.2 (28)	30.8 (24)
	2-3 times/week	50.0 (88)	42.7 (41)	44.9 (35)
	≥4 times/week	27.8 (49)	28.1 (27)	24.3 (19)
Poultry, % (n)	0-1 time/week	60.2 (106)	62.5 (60)	67.9 (53)
	2-3 times/week	35.2 (62)	36.5 (35)	30.8 (24)
	≥4 times/week	4,6 (08)	1.0 (01)	1.3 (01)
Eggs, % (n)	0-1 time/week	53.4 (94)	59.4 (57)	61.5 (48)
	2-3 times/week	37.5 (66)	32.3 (31)	28.2 (22)
	≥4 times/week	9.1 (16)	8.3 (8)	10.3 (8)
Diary products, % (n)	0-1 time/week	51.1 (90)	57.3 (55)	56.4 (44)
	2-3 times/week	37.5 (66)	26.0 (25)	30.8 (24)
	≥4 times/week	11.4 (20)	16.7 (16)	12.8 (10)
Green leaves vegetables, % (n)	0-1 time/week	38.1 (67)	44.8 (43)	52.5 (41)
	2-3 times/week	32.4 (57)	29.2 (28)	24.4 (19)
	≥4 times/week	29.5 (52)	26.0 (25)	23.1 (18)
Okro, % (n)	0-1 time/week	13 (23)	10.4 (10)	6.7 (5.2)
	2-3 times/week	53 (94)	47.9 (46)	44.0 (34.3)
	≥4 times /week	34 (59)	41.7 (40)	49.3 (38.5)
Others vegetables, % (n)	0-1 time/week	49.5 (87)	61.5 (59)	57.9 (44)
	2-3 times/week	40.3 (71)	27.0 (26)	32.9 (25)
	≥4 times /week	10.2 (18)	11.5 (11)	9.2 (7)
Fruits, % (n)	0-1 time/week	42.0 (74)	50.0 (48)	53.9 (41)
	2-3 times/week	47.2 (83)	35.4 (34)	35.6 (27)
	≥4 times /week	10.8 (19)	14.6 (14)	10.4 (8)
Oil and fats, % (n)	0-1 time/week	4.0 (07)	6.4 (06)	19.7 (15)
	2-3 times/week	18.2 (33)	21.9 (21)	44.7 (34)
	≥4 times /week	78.8 (137)	71.9 (69)	35.6 (27)
Condiments and spices, % (n)	0-1 time/week	5.1 (09)	5.2 (05)	15.8 (12)
	2-3 times/week	27.3 (48)	32.3 (31)	51.3 (39)
	≥4 times /week	67.6 (119)	62.5 (60)	32.9 (25)
Snacking, % (n)	0-1 time/week	82.4 (145)	87.5 (84)	93.4 (71)
	2-3 times/week	17.0 (30)	12.5 (12)	5.3 (4)
	≥4 times /week	0.6 (1)	0.0 (0)	1.3 (1)
Soda drink, % (n)	0-1 time/week	56.8 (100)	64.6 (62)	65.8 (50)
	2-3 times/week	37.5 (66)	27.1 (26)	31.6 (24)
	≥4 times /week	5.7 (10)	8.3 (8)	2.6 (2)
Alcohol, % (n)	0-1 time/week	15.9 (28)	51.0 (49)	52.6 (40)
	2-3 times/week	44.9 (79)	49.0 (47)	21.1 (16)
	≥4 times /week	39.2 (69)	0 (0)	26.3 (20)
Adding sugar in food, % (n)	0-1 time/week	64.8 (114)	65.6 (63)	64.5 (49)
	2-3 times/week	28.9 (51)	26.1 (25)	25.0 (18)
	≥4 times /week	6.3 (11)	8.3 (8)	10.5 (8)

Sweeted foods, % (n)	0-1 time/week	51.1 (90)	60.4 (58)	61.8 (47)
	2-3 times/week	38.6 (68)	30.2 (29)	29.0 (22)
	≥4 times /week	10.3 (13)	9.4 (9)	9.2 (7)
Eating away from home, % (n)	Yes	43.6 (71)	(23)	39 (30)

Table 4: Qualitative evaluation of dietary habits.

Variable	Maroua (n=176)	Kaele (n=96)	Midjivin (n=78)	*P* value
Dietary Diversity Score (DDS)	4.36±1.09[a]	3.73±1.15[b]	4.22±1.32[a]	0.0001
Food Consumption Score (FCS)	70.99±24.16[a]	63.21±26.01[b]	50.09±20.12[c]	0.0001

Results are expressed as mean±SD. Value with different letters are significantly different in the same line at $p<0.05$.

Table 5: Frequency of malnutrition and cardiometabolic risk factors according to the study area.

Variable	Maroua n (%)	Kaele n (%)	Midjivin n (%)	Total n (%)
Underweight	23 (13.1)	15 (16)	11 (14.5)	49 (14.2)
Overweight	24 (13.6)	15 (16)	16 (21.1)	55 (15.9)
Obesity	16 (9.1)	4 (4.3)	6 (7.9)	26 (7.5)
Abdominal obesity	36 (20.6)	13 (13.5)	18 (23.7)	67 (19.3)
High blood pressure	73 (41.7)	37 (39.4)	32 (43.8)	142 (41.5)
High total cholesterol level	85 (50.9)	26 (31.3)	24 (33.3)	135 (41.9)
High triglyceride level	38 (22.8)	23 (27.7)	16 (22.2)	77 (23.9)
Cluster of metabolic abnormalities				
1 abnormality	70 (39.8)	41(42.7)	30 (38.5)	141 (40.3)
2 abnormalities	48 (27.3)	19 (19.8)	15 (19.2)	82 (23.4)
3 abnormalities	18 (10.2)	04 (4.2)	07 (9.0)	29 (8.3)
4 abnormalities	03 (1.7)	02 (2.1)	02 (2.6)	07 (2.0)

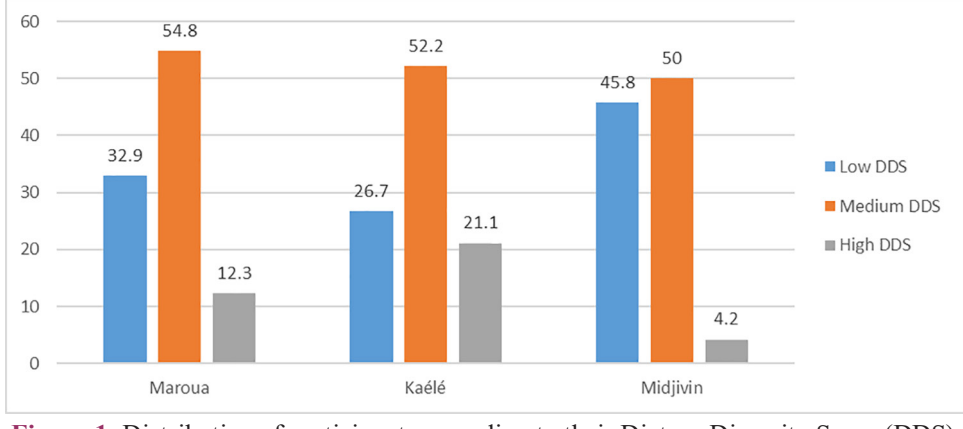

Figure 1: Distribution of participants according to their Dietary Diversity Score (DDS).

metabolic risk factor versus 39.8% in Maroua and 38.5% in Midjivin. Although 27.3% and 10.2% of Maroua dwellers had two and three metabolic risk factors respectively.

Discussion

The nutritional transition refers to the shift from a monotonous diet rich in starch and fibers, low in fats associated with an active lifestyle to a more diversified diet; but rich in refined sugars, saturated animal fats and processed foods, and low in fruits, vegetables and fibers with a sedentary lifestyle. Numerous studies have demonstrated the consequences of these changes on health (8-10). Therefore, this study aimed to assess the nutritional transition among populations living in the Far North Region of Cameroon. Results showed that nutrition transition is quite a reality in this part of the country. The study participants have begun the process of nutrition transition, even in rural areas. The evaluation of indicators of the degree of urbanization in the three study areas revealed that the urban population aspired to better living conditions, notably; the use of tap water (47.7% and

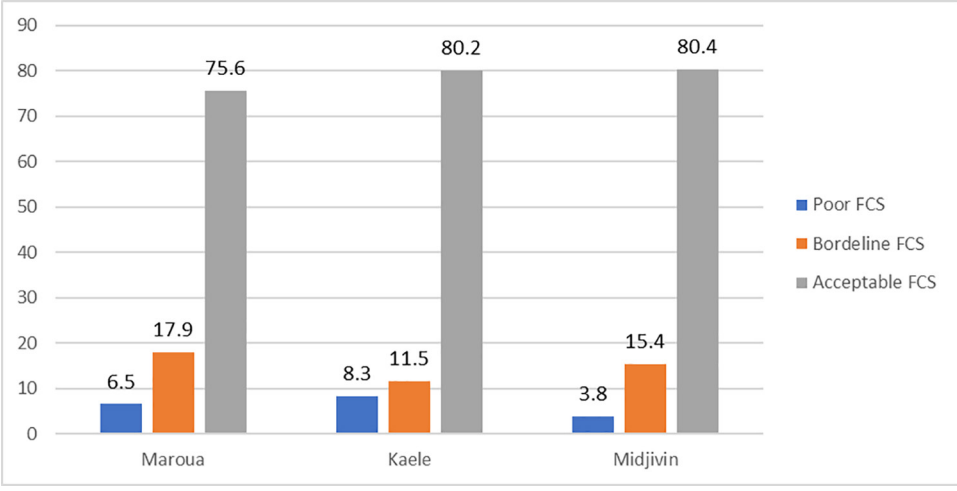

Figure 2: Distribution of participants according to their food consumption score (FCS).

47.9%, respectively in Maroua and Kaele), contrary to Midjivin, where the population used mostly public boreholes (65.4%) and public wells (26.9%).

The acquisition of comfort items obeyed the rural-urban gradient (car ownership, radio, television, refrigerator, motorcycle) except for the bicycle wildely used in rural area Midjivin as also demonstrated by Fezeu et al. (25). These results are in line with several studies which confirmed that the urbanization of society is accompanied by the modernization of assets (4, 5, 8). Moreover, urbanization directly influences the eating habits of an individual through the type of food consumed, the cooking method and even the frequency of consumption (26). Exploration of the participants' habits and lifestyles showed that they consumed almost all food groups. Low frequency of fruit and vegetable consumption, a characteristic of populations undergoing nutrition transition, was observed even in rural areas. These results are different from many other studies which showed an urban-rural gradient in terms of high frequency of fruit and vegetable consumption (27). This could be explained by the fact that the Far North Region is a Sahelian zone with climate challenges not favourable to the farming and production of fruits and vegetables. Moreover, the populations of the urban areas (Maroua and Kaele) benefit from the supply of foods from several villages, unlike those of the rural area (Midjivin), only consumed what they produced. In contrast to fruits and vegetables, there was a high consumption of red meat in the three study areas, because the Far North region is part of the productive basin with high livestock, guaranteeing the availability of meat in both rural and urban areas.

Qualitative assessment of dietary habits shows a rural-urban gradient of FCS and DDS. These results are consistent with the observations of Popkin *et al.* (28) who demonstrated that the nutrition transition is accompanied by a shift from a monotonous diet to a much more diversified diet. Heavy use of alcohol is one of the leading global risk factors for poor health outcomes, having a direct impact on a variety of diseases. Our study population had a high level of consumption, and mostly those living in the rural area regardless of the type of alcohol (traditional or modern). WHO has made similar observations among rural populations in Mozambique where about 77.2% were exposed to alcoholism like the urban population (29). This can be explained by the fact that these rural populations are large producers of local alcoholic beverages made from germinated sorghum, maize, yellow, and red millet (30).

The high prevalence of undernutrition noted in less urbanized areas, (14.5% in Midjivin and 16% in Kaele) was also reported by Ferede *et al.* (31) elsewhere. Furthermore, obesity and high total cholesterol were more common in Maroua than in Kaele and Midjivin that could be a result of disparities in lifestyle and diet in urban and rural environments (32). Indeed, urban populations are characterized by sedendarity and energy-dense diets. Also, the high proportion of participants consuming food away from home (generally energy dense) at Maroua may contribute to obesity (33). While, the low consumption of fruits and vegetables noted in urban areas would justify the high level of total cholesterol. The hypolipidemic properties of the fibres of vegetables via their ability to increase gastrointestinal transit with complexations of bile acids, leading to a decrease in the absorption of lipids and a reduction of endogenous cholesterol is known (34). The high exposure of rural dwellers to cardiometabolic risk factors (overweight, abdominal obesity, and hypertension) in our study revealed that they had begun the nutrition transition (35).

Maroua inhabitants were more exposed to the metabolic syndrome (≥3 metabolic anomalies) than Kaele and Midjivin and sedentarity characterizing urban population could justify this, since active lifestyle protects against visceral fat accumulation and leads to beneficial effects on cardiovascular, respiratory, and musculoskeletal metabolisms (28). These findings are consistent with those of Wang *et al*. (36) who showed that a sedentary lifestyle is associated with a positive energy balance in favour of overweight and obesity.

Conclusion

The nutritional transition is a reality in the Far North region of Cameroon, a Sahelian zone dominated by food insecurity and nutritional deficiency. The inhabitants of the three study sites are constantly seeking modern assets that can improve their living conditions. However, this is undoubtedly accompanied by the adoption of a modern lifestyle characterized by high alcohol consumption, low fruit and vegetable consumption and low dietary diversity. This can lead to the development of overweight/obesity and its complications (hypertension, hypercholesterolemia and hypertriglyceridemia) in both urban and rural areas. The populations of rural area (Midjivin) appeared to be at the same level of nutrition transition as those of urban area (Maroua).

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Conflict of Interest

None declared.

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