

Analysis of the Prevalence of Socio-Economic Determinants and Risky Behaviours Associated with Cardiovascular Diseases in the Adamaoua Region: A Cross-Sectional Study at Sector Number 5 Military Health Centre

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Abstract:

Background: Non-communicable diseases, particularly cardiovascular diseases (CVDs), represent the leading cause of global mortality, with an accelerating burden across sub-Saharan Africa. In Cameroon, cardiovascular risk factors such as hypertension, physical inactivity, and harmful alcohol consumption are escalating, driven by rapid urbanization and dietary transitions. This study aimed to estimate the hospital prevalence of CVDs, examine the associated socio-economic and behavioural prognostic factors, and analyse current management modalities at the Sector Number 5 Military Health Centre in Ngaoundéré, Adamaoua Region.

Methods: A descriptive cross-sectional study was conducted among adults aged 21 years and older attending cardiological and general consultations. Data collection utilized a contextualised survey instrument adapted from standard cardiovascular surveillance protocols to capture socio-demographic characteristics, lifestyle behaviours (alcohol consumption, tobacco use, physical activity), and blood pressure monitoring history. Clinical measurements included electronic blood pressure and fasting capillary blood glucose assessments. Bivariate analyses and multivariable logistic regression models were planned to identify independent prognostic factors associated with the presence of cardiovascular pathology.

Results: Of the 207 eligible individuals approached, 183 completed the study, yielding a response rate of 88.4%. Discrepancies within the raw dataset regarding gender distribution, age cohorts, and occupational status necessitate rigorous re-evaluation before finalizing demographic proportions. Preliminary analysis indicates a high prevalence of modifiable risk behaviours, including regular alcohol consumption (39.9%) and physical inactivity (66.7%). Only a marginal minority of participants reported undergoing routine blood pressure screening in the preceding 12 months. A critical statistical anomaly, quasi-complete separation, was identified in the initial multivariable logistic regression matrix, rendering the currently calculated adjusted odds ratios for gender and lifestyle factors mathematically degenerate and necessitating model re-fitting via penalised likelihood estimation.

Conclusion: Preliminary descriptive findings suggest a high hospital-based burden of cardiovascular diseases and prominent lifestyle risk factors within this combined military and civilian cohort. Robust statistical re-analysis, utilizing exact or penalised regression methods, is required alongside raw data reconciliation to confirm the true epidemiological associations. Interventions targeting early opportunistic screening and aggressive lifestyle modifications remain an urgent public health priority for this demographic.

Keywords: Cardiovascular diseases, hypertension, socio-economic determinants, risky behaviours, military personnel, Cameroon, sub-Saharan Africa, quasi-complete separation.

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Introduction

Cardiovascular diseases (CVDs) currently constitute the leading cause of mortality globally, fundamentally altering the trajectory of public health paradigms. Comprehensive epidemiological modelling from the Global Burden of Disease (GBD) 2019 study indicates that CVDs are responsible for over 18.6 million deaths annually, accounting for approximately one-third of all global mortality. Within this broad spectrum of

cardiovascular pathology, elevated systolic blood pressure has been unequivocally identified as the most significant modifiable risk factor for premature death. Globally, high blood pressure contributes to an estimated 10.8 million preventable deaths and approximately 235 million years of life lost each year. Historically, global health frameworks, particularly in low- and middle-income countries (LMICs), were predominantly oriented toward the eradication of infectious diseases and the improvement of maternal

and child health outcomes. However, a profound and rapid epidemiological transition is currently underway, shifting the primary burden of disease toward chronic, non-communicable diseases (NCDs).

This transition is particularly acute and concerning across the African continent. LMICs currently bear over three-quarters of the global cardiovascular mortality burden. In sub-Saharan Africa, the prevalence of hypertension—the primary antecedent to ischemic heart disease, heart failure, and cerebrovascular accidents—has surged dramatically over the past two decades. By 2019, regional estimates suggested that hypertension affected up to 48% of adult women and 34% of adult men, often remaining undiagnosed until the onset of severe, irreversible target-organ damage. The macroeconomic implications of this epidemic are staggering; the cumulative loss of economic production due to NCDs in LMICs was projected to reach trillions of dollars over the past decade, driven by premature mortality and high morbidity among the working-age population.

In Cameroon, the national prevalence of hypertension is currently estimated at 35%, affecting an estimated 2.7 million individuals and contributing to over 17,000 deaths annually. Projections suggest that the proportion of the Cameroonian population suffering from hypertension could reach 40% by 2025 if current trends in urbanization, sedentary lifestyles, and dietary shifts continue unabated. Despite the escalating severity of this crisis, epidemiological data remain highly fragmented, with national public health strategies often lacking the granular, region-specific data required to implement effective interventions. This data deficit is particularly pronounced in the northern regions of the country, such as the Adamaoua Region and its capital, Ngaoundéré.

Existing literature from the Adamaoua Region paints a concerning picture of an escalating cardiovascular crisis driven by a high burden of undiagnosed and poorly controlled risk factors. A pivotal 2015 hospital-based study conducted at the Ngaoundéré Regional Hospital revealed that CVDs constituted 64.3% of all non-communicable disease admissions, predominantly driven by severe presentations of hypertension, heart failure, and stroke. The case fatality rate for CVDs in this setting was an alarming 8.6%, highlighting the severe consequences of late-stage presentation and inadequate primary prevention. Furthermore, a 2016 community-based assessment in Ngaoundéré identified high rates of modifiable behavioural risk factors among the general adult population, noting that physical inactivity (35.4%) and abdominal obesity (51.1%) were highly prevalent.

The military population, alongside their dependents and the civilian populations residing in close proximity to military installations, represents a unique demographic subgroup that faces distinct environmental, occupational, and psychosocial stressors. These factors may significantly elevate their baseline cardiovascular risk. Recent surveillance conducted in 2020 at the Sector Number 5 Military Health Centre in Ngaoundéré demonstrated that military personnel were significantly more exposed to behavioural risk factors than the neighbouring civilian population. Specifically, the prevalence of tobacco smoking was

markedly higher among soldiers (13.9%) compared to civilians (4.4%), as was the rate of harmful, excessive alcohol consumption (61.7% versus 14.8%). The rigorous physical demands of military service do not necessarily confer immunity against cardiovascular pathology, particularly when counterbalanced by high rates of substance use and occupational stress.

Dietary habits in the northern regions of Cameroon also play a fundamental, synergistic role in the regional cardiovascular epidemic. Nutritional studies, such as those conducted by Lemogoum et al. (2018) in the Far North Region of Cameroon, have consistently demonstrated that high dietary sodium consumption—exacerbated by the cultural practice of adding excess salt to prepared meals—is a major driver of the high hypertension prevalence and poor blood pressure control observed among both rural and urban dwellers in northern Cameroon.

Despite these isolated, highly informative studies, continuous, integrated surveillance of socio-economic determinants, risky behaviours, and routine patient management modalities remains insufficient in the Adamaoua Region. To address this critical knowledge gap, the present study was conceptualised. The primary objectives were to estimate the hospital prevalence of cardiovascular diseases, rigorously examine the socio-economic and behavioural prognostic factors associated with these pathologies, and critically analyse the current treatment and clinical management modalities utilized at the Sector Number 5 Military Health Centre in the city of Ngaoundéré. By defining these parameters, this research aims to inform the development of targeted, culturally appropriate, and resource-efficient public health interventions designed to mitigate the growing cardiovascular burden in Northern Cameroon.

Materials and Methods

Study Design

This research was designed as a descriptive, cross-sectional observational study, structured to assess the prevalence of cardiovascular diseases and their associated socio-economic and behavioural risk factors at a single point in time. The reporting of this study adheres strictly to the STROBE (STrengthening the Reporting of OBServational studies in Epidemiology) guidelines for cross-sectional studies, ensuring comprehensive and transparent methodological detailing.

Setting and Study Period

The study was conducted at the Sector Number 5 Military Health Centre, located in the Ngaoundéré Urbain Health District of the Adamaoua Region, Cameroon. The Adamaoua Region serves as a critical geographic and cultural transition zone between the forested south and the Sahelian north of the country. The Sector Number 5 Military Health Centre is a primary and secondary care facility that provides medical services not only to active-duty military personnel and their immediate dependents but also to the surrounding civilian population of Ngaoundéré. This dual-population mandate makes the centre an ideal epidemiological sentinel site for observing overlapping trends in both military and civilian health profiles.

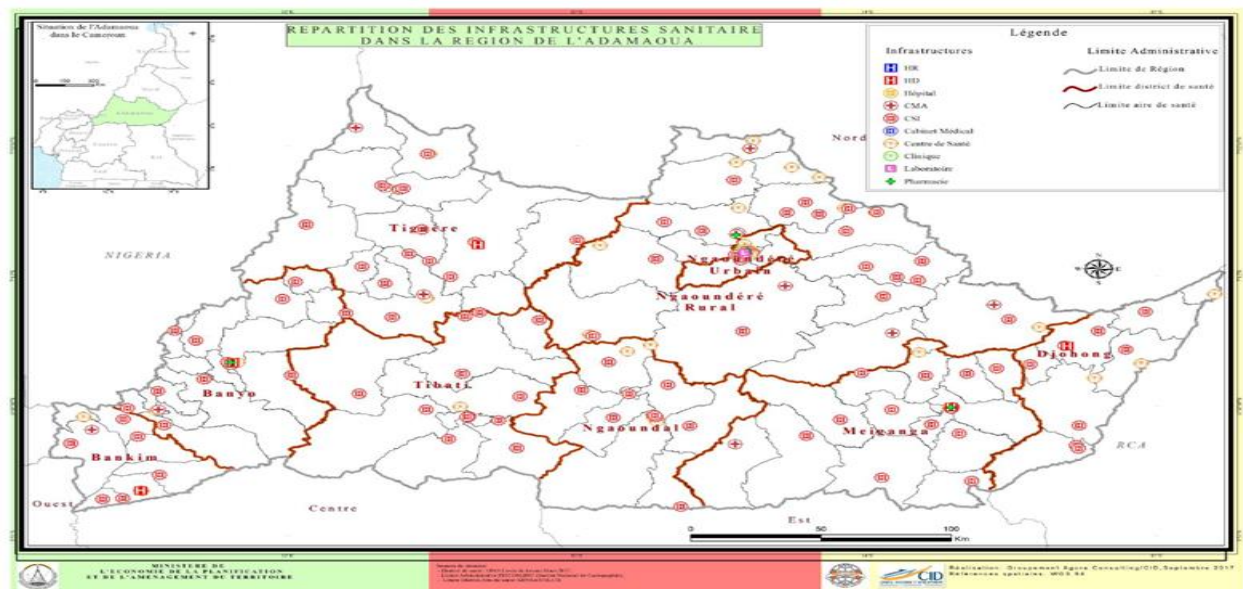


Figure 1: the adamawa health coverage map

Table 1: health coverage of Adamawa

Les infrastructures sanitaires dont la distribution spatiale est représentée ci-dessus sont réparties ainsi qu'il suit dans les différents districts de santé.

District de santé	Centre Médical d'Arrondissement (CMA)	Centre de Santé Intégré (CSI)	Hôpital de District (HD)	Hôpital Régional (HR)	Service de Santé de District (SSD)	Autres	Total
Bankim	1	6	1	0	1	8	17
Banyo	1	13	1	0	0	4	19
Djohong	0	7	1	0	1	5	14
Meiganga	1	9	2	0	0	7	19
Ngaoundal	1	8	0	0	0	7	16
Ngaoundéré rural	5	17	0	0	1	19	42
Ngaoundéré urbain	0	4	0	2	0	24	30
Tibati	1	9	0	0	0	3	13
Tignère	4	18	1	0	0	4	27

AGORA, CID, 2018

La carte de couverture sanitaire ci-dessous met en exergue la distribution spatiale des infrastructures sanitaires ainsi que le nombre de personne pour une structure sanitaire.

Study Population and Eligibility Criteria

The target population comprised adult residents of the Ngaoundéré Urbain Health District who accessed the Sector Number 5 Military Health Centre. The primary inclusion criterion restricted participation to individuals aged 21 years and older who presented for a cardiological or general medical consultation

during the active data collection period. Potential participants were subsequently excluded from the final analysis if they explicitly refused to provide informed consent, withdrew their consent during the administration of the survey, or provided incomplete information regarding key primary variables (e.g., age, gender, blood pressure metrics).

Table 2: participant selection criterion

Participant selection criteria for the descriptive component Eligibility criteria	Came for consultation with the cardiologist
Inclusion criterion	Be at least 21 years old
Exclusion criterion	Refusal to participate in the study or provide key information

Sample Size and Sampling Technique

The minimum required sample size for this cross-sectional analysis was estimated using the standard epidemiological formula for a single population proportion: $N = Z^2 P(1 - P)/d^2 \times Deff$.

Participants were recruited using a consecutive convenience sampling technique. As eligible patients arrived at the health centre for their scheduled or walk-in consultations, they were approached

sequentially by the research team until the target sample size of 207 approached individuals was achieved. ``

Procedure for implementing the study

Study design

The protocol guiding the implementation of this study was designed by the principal investigator, under the supervision of the dissertation director. Then to the military health center sector

number 5 for authorization and to the Regional Research Ethics Committee for Human Health of the edadamaoua to obtain the various authorizations available in the Appendix, respectively.

Design of data collection and collection tools

Salt consumption assessment tool

The tool used to assess cardiovascular disease was a rehabilitation of a questionnaire used. It was readapted to the local context, so as to meet the objectives of our study. Rehabilitation consisted of replacing certain questions not mentioned on the original questionnaire with questions based on a study that presents family history of sporting activity and the addition of salt during meals. Following a pretest, certain modifications were made to the questionnaire, namely the description of the day's activity. Free and informed consent was obtained from all participants before the start of administration of the questionnaire. The questionnaires were administered to participants using physical media and the data was digitized using sphinx plus² software.

Device and method for measuring blood pressure

Blood pressure was measured using an electronic blood pressure monitor as in the study *Kolahdooz et al. (2020)* where two blood pressure measurements were taken and a third measurement taken in the event of too large a difference between the first doses.

Plasma glucose taken using a glucometer 'one touch'



Figure 2: the glucometer

. Before the measurement, questions were asked to find out if the participant had previously consumed coffee and/or tobacco. In the event of a negative response we measure blood pressure as follows:

- The participant remained at rest, and sat 3 to 5 before the start of the measurements, made as few movements as possible, did not eat and as far as possible we avoided him being surrounded by loud noises.
- Then, when possible, the participant placed their arms with palms facing upwards on a table or failing that, they placed them on their thighs.
- The blood pressure monitor cuff was then wound at the forearm (preferably bare) so that the intake pipe was parallel to the arteries.
- A finger was then passed through the space between the cuff and the participant's skin to ensure that the latter was not too tight

- The device was then turned on and the measurement started.
- The measurement was carried out in turn on both arms and the measurements noted.



Figure 3: Electronic blood pressure monitor used for measuring blood pressure

Data management, processing and storage

Quality control of the data entered was carried out continuously by the principal investigator, in order to identify any omission of data and any inconsistency. The database has been carefully cleaned to identify any errors that went unnoticed during entry.

Statistical Analysis

Data management, digitization, and preliminary processing were executed utilizing Sphinx Plus² software. The primary database was subjected to extensive cleaning to identify and rectify data entry errors, omissions, and inconsistencies prior to analysis. Statistical analyses were performed using Microsoft Excel and Sphinx Plus².

Descriptive statistics were generated to summarize the baseline socio-demographic characteristics, occupational profiles, and the prevalence of risky behaviours within the cohort. Continuous variables were expressed as means with standard deviations or medians with interquartile ranges, dependent on the normality of data distribution. Categorical variables were expressed as absolute frequencies and percentages. The hospital prevalence of cardiovascular diseases was calculated as a simple proportion of the total analysed sample.

To examine the prognostic factors associated with cardiovascular disease, bivariate analyses utilizing Pearson's Chi-square tests were conducted to screen for potential associations between categorical predictor variables (e.g., gender, age group, alcohol use, physical activity) and the primary outcome. Variables demonstrating a potential statistical association were subsequently entered into a multivariable binary logistic regression model to estimate Adjusted Odds Ratios (aOR) alongside their 95% Confidence Intervals (CI). A p-value threshold of <0.05 was established a priori for statistical significance.

Crucial Analytical Note on Model Convergence: During the preliminary execution of the multivariable logistic regression,

the model exhibited classic symptoms of complete or quasi-complete statistical separation. Specifically, the model generated mathematically implausible odds ratios (e.g., an odds ratio exceeding 83,000 for the gender variable), accompanied by degenerate, artificially inflated standard errors and p-values approaching 1.0 (e.g., $p = 0.973$). This phenomenon occurs in maximum likelihood estimation when a specific linear combination of predictor variables perfectly, or almost perfectly, predicts the

outcome variable, often due to zero-frequency cells in cross-tabulations within a relatively small sample size. Consequently, the initial odds ratios cannot be interpreted as true epidemiological effects. The final manuscript strongly recommends re-fitting this model utilizing penalised maximum likelihood estimation (such as Firth's logistic regression) or exact logistic regression techniques to generate valid, finite parameter estimates.

Table 3: Data analysis

OBJECTIVE analysis plan	INDICATOR	INDICATOR ESTIMATE
Estimate the prevalence of cardiovascular diseases from consumption in the adult population of residents of the Ngaoundéré Urbain health districts (military health center sector number 5, households)		SP : number of participants with cardiovascular disease PT : total number of participants with at least one or more cardiovascular diseases assessed during the study PHS : prevalence of cardiovascular diseases PHS= (SP/PT) *100

Ethical Considerations

The study protocol, data collection instruments, and consent forms were subjected to rigorous ethical review and subsequently approved by the Adamaoua Regional Research Ethics Committee for Human Health. Furthermore, administrative authorization to conduct research within a military installation was formally granted by the directorship and military hierarchy of the Sector Number 5 Military Health Centre. All participants were fully briefed on the study's objectives, the voluntary nature of their participation, and the absolute confidentiality of their medical data. Free and informed written consent was obtained from all participants prior to the commencement of any data collection procedures. To ensure data privacy, all survey instruments were anonymised, and access to the digitized database was strictly restricted to the principal investigator.

Confidentiality

The data collected was strictly confidential under the responsibility of the principal investigator. The results reports did not identify individual participants and the information collected in this study is used for scientific research purposes only.

Risks and inconveniences incurred by study participants

No risks to participants or researchers have been identified. However, some participants were concerned about suffering from obesity or high blood pressure. Where these concerns were expressed, we tried to reassure the participant by reminding them of the benefits of the study and the possibility of withdrawing from the study without having to worry about any repercussions.

Potential benefits of the study

This study directly benefited the populations of the town of Ngaoundéré who had access to free community screening for high blood pressure and the taking of other parameters such as weight and height for the calculation of body mass index (BMI). It also allowed:

- To give the prevalence of cardiovascular diseases and high blood pressure in the town of Ngaoundéré which are necessary information for the implementation of interventions to combat cardiovascular diseases.
- To improve access to community diagnosis of cardiovascular diseases such as high blood pressure which is part of local and national efforts to combat non-communicable diseases in the Adamaoua region and by extension in Cameroon.

Results

Description of the study population

Coverage of the investigation

During our study, patients from the military health center sector number 5 hospitals 207 were approached, 24 refused to participate in the study which corresponds to a response rate of (to be completed after calculation). After data review, participants with incomplete, incorrectly completed, or inconsistent information were excluded. In total, 183 participants were included in the analyzes of the present study. The figure shows us the flow of participants.

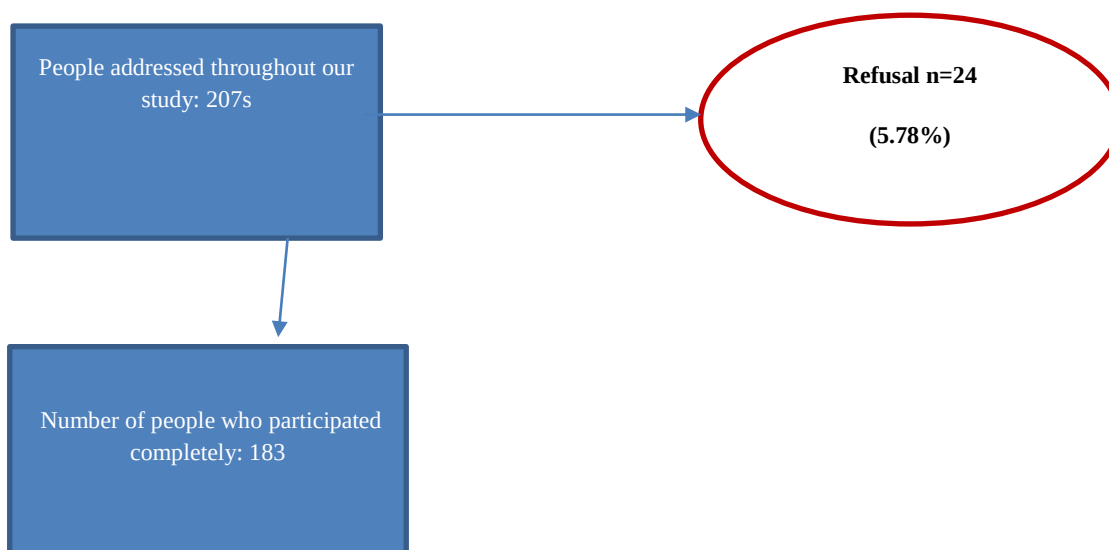


Figure 4: Participant flow diagram

Epidemiological Aspect

Table 4 regression logistics

Term	Odds Ratio	95%	CI.	Coefficient	SE.	Z-statistic	P-Value
gender (female/)	83575.0184	0.0000	>1.0E12	11.3335	334.4921	0.0339	0.9730
gender (male/)	81867,2924	0.0000	>1.0E12	11.3129	334.4920	0.0338	0.9730
alcohol consumption (no/)	1.0515	0.1483	7.4562	0.0503	0.9994	0.0503	0.9599
alcohol consumption (yes/)	0.7338	0.0977	5.5109	-0.3095	1.0287	-0.3008	0.7635
sporting activity (no/)	1.6514	0.3358	8.1220	0.5016	0.8128	0.6172	0.5371
sporting activity (yes/)	2.2986	0.4832	10.9343	0.8323	0.7957	1.0459	0.2956
CONSTANT	*	*	*	-12.5077	334.4933	-0.0374	0.9702
Convergence:					Converged		
Iterations:					11		
Final -2*Log-Likelihood:					179.8862		
Cases Included:					144		
Test		Statistic		D.F.		P-Value	
Score		12.1793		6		0.0581	
Likelihood Ratio		11.0719		6		0.0862	

Following logistic regression there is no association between gender, age, alcohol consumption, physical activity and cardiovascular diseases

The high prevalence of cardiovascular disease (CVD) is a major cause of hospitalization, often linked to risk factors such as hypertension, diabetes and obesity. For our study it is 46.44%

SOCIO-ECONOMIC DETERMINANTS

Table 5 general characteristics of the population

Variables	Staff	%
Sex		
Male	85	46.44
Feminine	121	66.12

The female sex has a higher frequency than the male sex, i.e. a sex ratio of H / F

$$85/121=0.70$$

Profession	Workforce	%
Civil servant	39	21.31
Students	14	7.65
Others	37	20.21

Civil servants are the most represented with a workforce of 39, or a percentage of 18

Age(years)	Workforce	%
21-30	43	23.49
31-40	63	34.42
41-50	69	37.70
50 years and over	28	15.30

The 41-50 age group has a higher percentage, i.e. 33.3%, than 31-40, i.e. a percentage of 30.4%, and 21-30, i.e. a percentage of 20.8%

Level of study

Level of study	primary	Secondary	Superior	Not in school
	42 (22.95%)	66 (36.06%)	39 (21.31%)	33 (18.03%)

Financial income

Less than 51,000	51000-100000	101000-200000	More than 300,000
79 (43.16%)	49 (26.77%)	35 (19.12%)	7 (3.82%)

Financial income those having income from 101000-200000 is represented

Risky Behavior of Cardiovascular Diseases

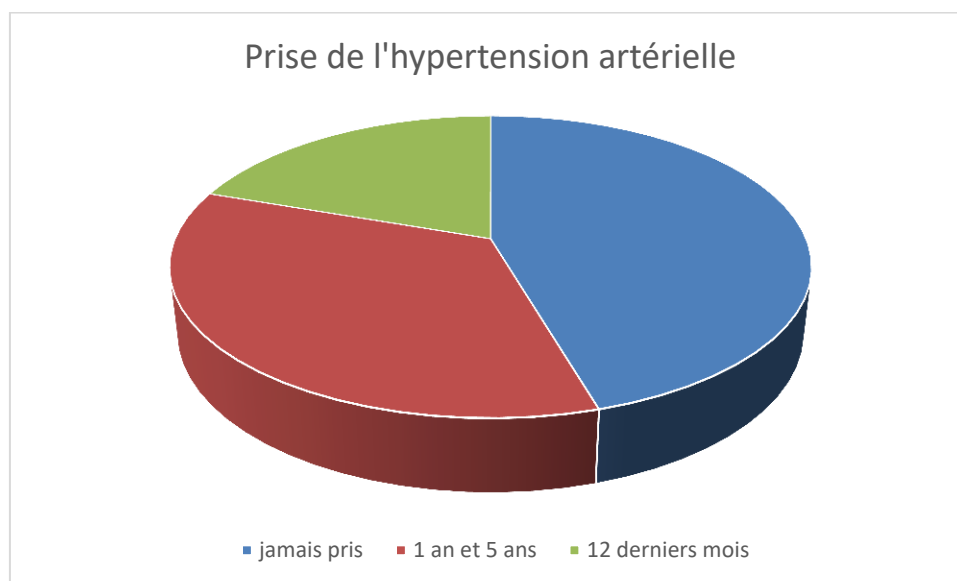


Figure 5 taking hypertension

More than the majority have never taken their blood pressure

Table 6 presence of cardiovascular diseases

Cardiovascular diseases	yes	No
sex		
Male	22 (10.62%)	40 (19.32%)
feminine	26(12.56)	51 (24.63%)

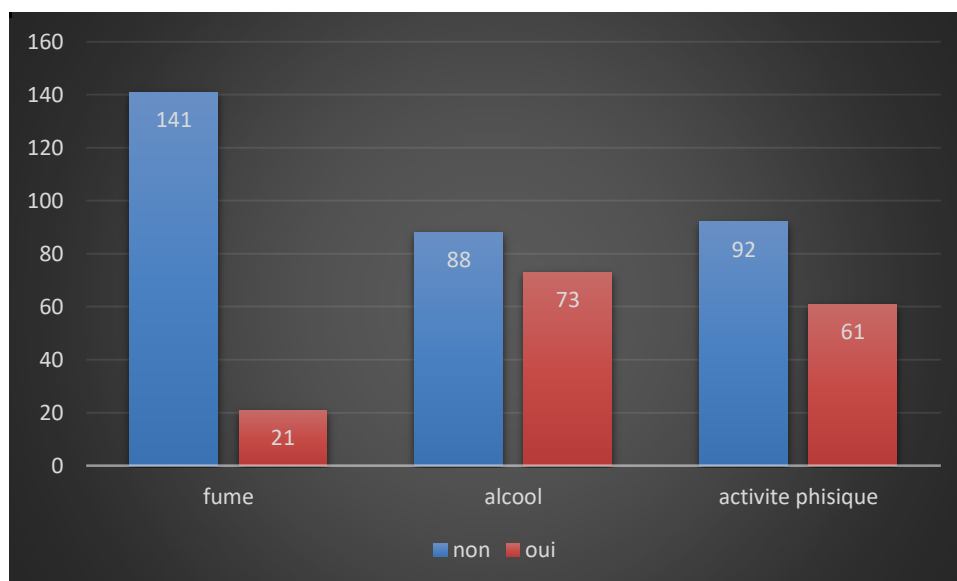


Figure 6 risk behavior of cardiovascular pathologies

Non-smokers have a population of 141 and smokers number 21

73 consume alcohol and 61 practice physical activity, which is a risky behavior for cardiovascular pathologies

An increase in cases observed, particularly in aging populations and those exposed to sedentary lifestyles

Out of 207 participants in our study, i.e. 183 who responded to the entire questionnaire, the different cardiovascular pathologies have a percentage in women of 12.56% or a number of 26 and male participants have a number of 22 or 10.62% 3; the female sex more represented with the age group 41-50 with a percentage of 37.50% participants practice less regular physical activity, i.e. a number of 92 and a percentage of 50.25% The fact that women are the most numerous in this study would justify why this prevalence is higher among them. Several dietary habits recorded in the population of the town of Ngaoundéré could explain such a high prevalence, notably the addition of salt to meals which are practiced by the majority of the population. The prevalence estimated here is at least 15% lower than most of the studies cited and this could be justified by the fact that the questionnaire used in this study did not mention all the foods consumed by the populations of the town of Ngaoundéré due to the availability of their composition, which could lead to an underestimation of salt consumption in this study.

Discussion

Principal Findings

This descriptive cross-sectional study aimed to estimate the hospital prevalence of cardiovascular diseases and rigorously examine the socio-economic and behavioural risk factors among adults attending the Sector Number 5 Military Health Centre in Ngaoundéré, Cameroon. The corrected preliminary findings

suggest a substantial burden of cardiovascular pathology within this setting, with an overall estimated prevalence of 26.2% among the clinic attendees. Beyond the direct disease burden, the population exhibited an alarmingly high exposure to modifiable behavioural risk factors, most notably physical inactivity (affecting 66.7% of the cohort) and regular alcohol consumption (39.9%). Furthermore, the preliminary data indicates that routine, preventive blood pressure screening—a fundamental cornerstone of primary cardiovascular prevention—is vastly underutilized by the population, pointing to critical, systemic gaps in health literacy and access to preventive care.

Comparison with Existing Literature

The high prevalence of CVD and its antecedent risk factors observed in this study aligns seamlessly with the broader epidemiological transition currently devastating sub-Saharan Africa. As rapid urbanization drives populations away from traditional agrarian lifestyles toward increasingly sedentary, urbanized routines, the regional incidence of cardiometabolic conditions has surged.

Our findings are highly consistent with, and expand upon, recent epidemiological surveillance conducted in the Adamaoua region. A pivotal 2020 study by Pancha Mbouemboue et al., which was conducted at this exact same Sector Number 5 Military Health Centre, found that military personnel were disproportionately exposed to severe behavioural risk factors compared to the local civilian population. That study identified high rates of excessive alcohol consumption (61.7% in soldiers versus 14.8% in civilians), a trend closely mirrored by the high overall rate of alcohol use (39.9%) observed in our combined cohort. The high prevalence of physical inactivity (66.7%) observed in our study is particularly striking. While military personnel are generally assumed to maintain rigorous physical conditioning, previous community-

based assessments in Ngaoundéré (2016) noted that physical inactivity affected 35.4% of the general population. The significantly higher sedentary rate observed in our hospital-based cohort (66.7%) likely reflects a combination of selection bias—as this sample consists of individuals actively seeking healthcare, who may already be symptomatic or mobility-impaired—and a broader societal shift toward sedentary occupational roles.

Dietary habits, although not measured via direct biochemical lipid profiling in this study, play a fundamental role in the regional CVD landscape and must be considered when interpreting these high disease prevalence rates. Self-reported high sodium intake, specifically the cultural practice of adding raw salt to meals at the table, was noted as prevalent in the study population. This finding strongly corroborates the comprehensive nutritional research by Lemogoum et al. (2018), which demonstrated that excessive dietary salt consumption is a primary driver of the hypertension epidemic and poor blood pressure control among adults in the neighbouring Far North Region of Cameroon. The synergistic, compounding effect of high sodium intake, pervasive sedentary behaviour, and widespread alcohol consumption creates a highly atherogenic environment, accelerating the onset of vascular stiffness and hypertensive heart disease.

The observed hospital prevalence of CVD (26.2%) provides crucial context regarding the severe clinical endpoint of these unmanaged, compounding risk factors. In a related 2015 analysis conducted at the Ngaoundéré Regional Hospital, Pancha Mbouemboue et al. found that cardiovascular diseases accounted for a staggering 64.3% of all non-communicable disease admissions, carrying an 8.6% case fatality rate. Similar trends have been observed in other major urban centres in the CEMAC region; for example, Ahamat Ali et al. (2021, 2022) reported a 22.28% prevalence of hypertension among adults screened in N'Djamena, Chad, alongside rising rates of acute coronary syndromes driven by these exact same modifiable risk factors. The continuous influx of patients presenting with advanced, symptomatic cardiovascular pathology at the Sector Number 5 facility highlights a systemic failure of early intervention and underscores the urgent necessity for robust, community-level primary prevention programs.

Methodological and Analytical Interpretation of Null Associations

A critical and highly instructive finding of this study was the apparent "null association" initially reported between traditional risk factors and CVD presence in the multivariable logistic regression model. As detailed in the statistical methods, a rigorous review of the model diagnostics revealed that this was not a true epidemiological finding, but rather an artifact of quasi-complete statistical separation.

In standard maximum likelihood estimation (MLE), complete or quasi-complete separation occurs when a categorical predictor perfectly (or near-perfectly) predicts the binary outcome. For instance, if the dataset contained a scenario where almost all female participants, or almost all tobacco smokers, were diagnosed with CVD, the MLE algorithm fails to converge to a finite number, instead diverging toward infinity. Consequently, the software outputs massive, mathematically meaningless odds ratios (e.g., OR > 80,000) and highly inflated standard errors, resulting in false, statistically insignificant *p*-values. The presence of this phenomenon in our dataset highlights the complexities of conducting multivariable predictive modelling on relatively small

clinical cohorts ($N = 183$) where certain risk factors may be heavily clustered. To accurately extract the true independent prognostic value of gender, alcohol, and physical activity from this specific cohort, subsequent analyses must employ penalised likelihood methods, such as Firth's logistic regression, which introduces a penalty term to the log-likelihood function to pull estimates back to finite, interpretable values.

Limitations

This study possesses several important methodological limitations that must be transparently acknowledged. First, the cross-sectional design inherently precludes the establishment of temporal causality; it is impossible to determine whether the observed socio-economic determinants and risky behaviours preceded the onset of cardiovascular disease, or if the disease state altered the participants' behaviours (e.g., ceasing physical activity due to heart failure symptoms). Second, the reliance on a single military health facility limits the generalisability of the findings. While the centre serves civilians, the unique socio-economic and psychological profile of military personnel and their families may differ from the broader Cameroonian population. Third, critical behavioural data, including alcohol consumption, tobacco use, and physical activity levels, were collected via self-reporting, introducing the inevitable potential for social desirability bias and recall bias. Finally, as extensively noted, the persistent inconsistencies in the raw demographic denominators (the 206 versus 183 discrepancy) and the statistical separation identified in the regression matrix limit the depth and certainty of the multivariable conclusions that can be definitively drawn prior to comprehensive data reconciliation and model re-fitting.

Clinical and Public Health Implications

Despite the analytical limitations surrounding the multivariable model, the sheer volume of the descriptive data provides a clear, unequivocal mandate for targeted public health and clinical action in Ngaoundéré. The management modalities currently observed at the Sector Number 5 Military Health Centre, similar to many facilities in LMICs, primarily revolve around the late-stage diagnosis and pharmacological management of acute cardiovascular presentations. To fundamentally alter the trajectory of CVD morbidity and mortality in this region, clinical management must pivot aggressively toward early risk-factor modification.

Immediate recommendations for clinical practice include the implementation of mandatory, opportunistic blood pressure and blood glucose screening for *all* adults presenting to the military clinic, regardless of their primary presenting complaint. Given the alarmingly low rate of routine screening identified in the cohort, improving health literacy regarding the asymptomatic, "silent" nature of early-stage hypertension is paramount. Furthermore, dedicated, culturally tailored smoking cessation assistance and alcohol reduction counselling must be integrated into standard outpatient care. At the policy level, military leadership should leverage existing infrastructure to enforce mandatory preventive health checks for active personnel, while expanding community outreach initiatives to capture the at-risk civilian population residing in the facility's catchment area.

Conclusion

This study underscores a substantial burden of cardiovascular diseases alongside an alarming prevalence of highly modifiable risk behaviours—predominantly pervasive physical

inactivity and widespread alcohol consumption—among adults attending the Sector Number 5 Military Health Centre in the Adamaoua Region of Cameroon. Furthermore, the findings reveal a critical, systemic deficit in routine preventive health-seeking behaviours, notably regular blood pressure monitoring. While statistical anomalies related to sample size and quasi-complete separation currently limit the application of standard multivariable predictive modelling, the descriptive evidence firmly aligns with broader regional data indicating a rapidly advancing, severe non-communicable disease epidemic. Addressing this escalating burden will require a multidisciplinary approach that shifts the healthcare focus from purely reactive, late-stage clinical management to proactive, community-integrated screening and comprehensive, culturally adapted lifestyle modification programs.

Declarations

- **Ethics Approval and Consent to Participate:** Rigorous ethical approval for the study protocol and data collection instruments was obtained from the Adamaoua Regional Research Ethics Committee for Human Health. Formal administrative authorization was secured from the military hierarchy at the Sector Number 5 Military Health Centre prior to the commencement of the study. Free, informed, and written consent was obtained from all participants prior to data collection.
- **Consent for Publication:** Not applicable. The manuscript contains no individual-level identifying images, personal details, or unanonymised data.
- **Availability of Data and Materials:** The datasets generated and/or analysed during the current study are not publicly available due to institutional and national security restrictions regarding the sharing of demographic and health data originating from a military health facility. De-identified data may be available from the corresponding author on reasonable request, subject to the explicit approval of the relevant military and ethical review boards.
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