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Assessment of Cardiovascular Risk in Prehypertensive Subjects in Kisangani (DR Congo): An Analytical Cross-Sectional Study Using the ISH/WHO Score

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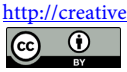

Abstract

Background: Prehypertension (PHTN) is an emerging cardiovascular risk factor in sub-Saharan Africa. The aim of this study was to assess the overall cardiovascular risk in prehypertensive subjects in the city of Kisangani. **Methods:** An analytical cross-sectional study was conducted on 344 prehypertensive adults recruited by stratified random sampling. The 10-year cardiovascular risk was assessed using the ISH/WHO score. Descriptive and inferential analyses were performed to identify factors associated with elevated cardiovascular risk. **Results:** The prevalence of high cardiovascular risk (≥20%) was 32.7%. Older age (AOR = 4.27; CI 95%: 2.59 - 7.06; p < 0.001), male sex (AOR = 1.86; CI: 1.14 - 3.02; p = 0.013), smoking (AOR = 2.41; CI 95%: 1.44 - 4.08; p = 0.001), low physical activity (AOR = 1.75; CI: 1.08 - 2.86; p = 0.025), diabetes mellitus (AOR = 3.92; CI: 1.78 - 8.77; p = 0.001), dyslipidaemia (AOR = 2.15; CI 95%: 1.32 - 3.50; p = 0.002) and obesity (AOR = 2.76; CI 95%: 0.93 - 2.53; p = 0.005) have been independently associated with this elevated risk. **Conclusion:** A significant proportion of prehypertensives in Kisangani have a high cardiovascular risk, which underlines the need of adding global risk assessment into the management of prehypertensives and to develop targeted prevention strategies.

Keywords

Assessment, Cardiovascular Risk Factor, Prehypertension, Adult, Kisangani

1. Introduction

Non-communicable diseases (NCDs) are the leading cause of deaths, resulting in

41 million deaths annually and accounting for more than three-quarters of all deaths globally [1].

NCDs disproportionately affect people in low- and middle-income countries, where more than 75% of global NCD deaths and 86% of premature deaths (death between 30 and 70 years) occur [1] [2].

In sub-Saharan Africa, NCDs have been projected to overtake communicable, maternal, neonatal, and nutritional diseases combined as the leading cause of mortality by 2030 [3].

A new classification for high blood pressure was established in 2003 by JNC7 with the introduction of the term "prehypertension", which serves as an early warning sign for the possible development of hypertension and cardiovascular disease [4]. Young individuals are increasingly affected by this illness, which is known as prehypertension (PHTN), particularly in low- and middle-income nations [5]. Cardiovascular disease risk is increased by PHTN, which is a serious health concern even if it does not develop into full-blown hypertension. PHTN can quickly progress to hypertension, especially when blood pressure is near the threshold for hypertension [6].

Recent data indicates that this condition affects between 32.9% and 56.8% of the adult population in sub-Saharan Africa [7]. PHTN not only represents a potential future risk of hypertension, but it is also an independent risk factor for the development of cardiovascular disease, even in the absence of other simultaneous risk factors [8].

The frequency of cardiovascular risk factors, and the high mortality associated with them, have led practitioners grouped together in learned societies to develop diagnostic, therapeutic and preventive strategies. These strategies have led to the concept of overall cardiovascular risk, which must be assessed using recognised methods based on solid epidemiological studies [9].

The modern method of cardiovascular prevention now advocates an overall assessment of cardiovascular risk rather than individual management of risk factors. This method makes it easier to identify high-risk individuals who could benefit from intensive preventive measures, even if their individual risk factors are not necessarily very high. The risk score developed by the International Society of Hypertension/World Health Organisation (ISH/WHO), which is one of the risk stratification instruments, has been specifically designed for resource-limited environments and has been validated in various African populations [10].

In the Democratic Republic of the Congo (DRC), there is a notable increase in non-communicable diseases, with cardiovascular issues being particularly alarming. Hypertension is widespread, affecting as much as 41.4% of the urban population [11].

The DRC, like many other African countries, is experiencing an epidemiological change, with both infectious and chronic non-communicable illnesses prevalent. This combined load puts a significant pressure on the DRC's already overburdened healthcare system, underscoring the need of primary prevention, espe-

cially in the treatment of PHTN.

Cardiovascular risk assessment, which takes into account several risk factors simultaneously, is essential for identifying high-risk individuals and implementing appropriate prevention strategies.

Data on cardiovascular risk factors in the general population is scarce, if not virtually non-existent, in developing countries in general and in DRC in particular.

With this in mind, the aim of this study, which is the first to be carried out in our region, is to fill this gap. It is taking place in the city of Kisangani, the capital of Tshopo Province. This city, similar to other urban areas in sub-Saharan Africa, is characterised by a high prevalence of cardiometabolic risk factors and a fragile local healthcare system, faced with a double burden of morbidity: the persistence of infectious diseases such as malaria and HIV, and the rapid emergence of cardiovascular pathologies.

The main objective of this study is to assess the global cardiovascular risk in pre-hypertensive subjects in Kisangani, using the WHO/ISH score, which was specifically developed for countries with limited resources. This score was chosen for its simplicity, accessibility, flexibility and ability to prioritise interventions. Its use in cardiovascular risk assessment is particularly relevant in Africa, as it can improve the management of cardiovascular disease in a context of limited resources.

The specific objectives of this research include 1) determining the prevalence of cardiovascular risk among pre-hypertensives in Kisangani, 2) assessing their overall cardiovascular risk, and 3) identifying factors associated with high cardiovascular risk.

2. Methods

2.1. Framework and Nature of the Study

We conducted a cross-sectional analytical study in Kisangani city from June 2024 to December 2024.

2.2. Study Population, Sampling Procedure, and Sample Size

The population studied comprised the inhabitants of Kisangani. We calculated the sample size using the formula $z^2p(1 - p)/d^2$. With a known prevalence of PHTN in the adult population of Kisangani where "p" is estimated to be 33.8% [12], and an admissible error "d" of 5% with a 95% confidence interval, the minimum sample size was set at n = 344.

Using a stratified sampling technique, this sample was dispersed among the five Health Zones (the Lubunga Health Zone was not included for security reasons). First, we chose four Health Areas at random from the entire list of Health Areas in the Health Zones. We selected two avenues at random from each Health Area, and we used systematic sampling to choose homes in each avenue. Counting every house on the avenue (N), dividing the total by the number of subjects required to

calculate the sample interval (k), choosing the first house to survey, and then adding the sampling interval to get the desired number were the steps involved in this method.

2.3. Selection Criteria

Participants had to meet the following criteria to be included in the study: they needed to be at least 30 years old, have lived in Kisangani for a minimum of 6 months, and agree to participate in the study.

The following were excluded from this study:

- Hypertensive subjects (with or without treatment).
- Subjects with severe chronic disease (such as end-stage renal disease, systemic inflammatory or autoimmune diseases, active cancer or cancer under treatment).
- Pregnancy or breast-feeding: Pregnant or breast-feeding women were excluded because of the physiological changes and potential dangers associated with pregnancy.
- Subjects use drugs that may affect blood pressure, such as corticosteroids, substances known to alter blood pressure levels, oestrogen-based oral contraceptives, etc.
- Subjects with cognitive problems or communication difficulties.
- People who do not live in the city of Kisangani and those with a temporary residence in the region.

2.4. Study Variables

The study covered a range of parameters, including socio-demographic, anthropometric, clinical, biological and lifestyle data.

2.5. Data Collection

Data was gathered by skilled interviewers utilising a standardised and organised questionnaire.

Depending on our research goals, a few changes were made to the WHO STEPWISE questionnaire to make it more appropriate for the local setting. For instance, the following factors were not considered: household income, sociocultural background, the type of fat used in cooking, etc.

Anthropometric and blood pressure data are intended to be gathered using the WHO STEPwise questionnaire. Blood glucose and blood cholesterol laboratory tests are also included in the extended version used in this investigation. The training of interviewers and a double entry procedure guarantee the quality of the data.

The KoboCollect smartphone app, version v2022.4.4, was used to enter data. A calibrated Omron automatic digital monitor (Omron HEM-757; Omron Corp, Tokyo, Japan) was used to measure blood pressure after participants had rested for fifteen minutes in a seated position in a quiet setting, away from food and tobacco.

The average of the measurements was noted. At 5-minute intervals, three measurements were made to make sure the participant had been sitting still for at least five minutes. We averaged the last two measurements for analysis. A well-calibrated SECA scale was used to measure weight on a level, stable surface while participants were unshod and only loosely dressed. The results were expressed in kilogrammes (kg).

A portable height gauge was used to measure each person's height in centimetres (cm), without their wearing hats or shoes. Using a standard new soft tape measure, the waist circumference (in centimetres) was measured on each side, halfway between the top edge of the iliac crest and the lower edge of the final rib, along the middle axillary line. By dividing weight (in kilogrammes) by height (in meters squared), the body mass index (BMI) was determined.

A validated Food Frequency Questionnaire (FFQ) was employed to assess fruit intake, while the International Physical Activity Questionnaire (IPAQ) was used to document health-related behaviors, including levels of physical activity. The study adhered to the criteria set forth in the Declaration of Helsinki. Respondents were assured of their anonymity and confidentiality. Participation was voluntary, following a thorough explanation and obtaining free informed consent.

2.6. Data Quality Management

The questionnaire was created by an Internal Medicine Specialist from the University of Kisangani's Faculty of Medicine and Pharmacy. Face validity and content validity tests were performed by a public health specialist researcher from the same faculty to guarantee its applicability to the local population.

The data collection tool, important variables, and their measures were covered in a week-long training for data collectors and their direct supervisors. Five percent of the sample size—those having socioeconomic traits comparable to those of the research population—were given a pre-test.

Additional training was given to the data gathering crew in light of the problems found and the lessons learnt during the pre-test. Blood sample collection standard operating procedures were taught to laboratory technicians. Daily supportive supervision was given by the principle investigator and field supervisors during the data collection period. Any conflicting or missing information was sent back to the data collectors for revision.

2.7. Assessment of Overall Cardiovascular Risk

The ISH/WHO, developed specifically for African countries, was used to assess overall cardiovascular risk. This score helps predict the risk of serious cardiovascular events (such as heart attack or stroke) over a ten-year period, taking into account factors such as age, gender, smoking habits, systolic blood pressure, the existence of diabetes and total cholesterol levels.

We used the ISH/WHO risk tables specific to the Africa D region, which includes the DRC, for each participant. According to ISH/WHO guidelines, risk was

categorised in four degrees: low (<10%), moderate (10% - 20%), high (20% - 30%) and extremely high (>30%). In some studies, we combined the categories into a single one, differentiating low risk (<10%) from moderate to very high risk (≥10%).

2.8. Operational Definitions

According to WHO criteria, a prehypertensive individual is defined as having a systolic blood pressure between 120 and 139 mmHg and/or a diastolic blood pressure between 80 and 89 mmHg. An individual is classified as lean if their BMI is less than 18 kg/m^2, normal if their BMI is between 18 and less than 25 kg/m^2, overweight if their BMI is between 25 and 30 kg/m^2, and obese if their BMI is 30 kg/m^2 or higher. Physical inactivity was defined as the absence of daily physical activity or the presence of physical activity lasting less than 150 minutes per week. Active smoking was considered a risk factor when it was current or recently discontinued. Alcoholism was retained for alcohol consumption plus 3 glasses of beer (male) or two glasses (female) per day. Subjects who smoke cigarettes, whether regularly or sporadically, are classified as current smokers if they have smoked a minimum of 100 cigarettes in their lifetime.

2.9. Statistical Analysis

The data were analysed using SPSS software, version 26. Continuous variables are presented in terms of means ± standard deviations, while categorical variables are expressed as frequencies and percentages. Comparisons between groups were made using Student's t-test or Mann-Whitney test for continuous variables, and chi-square test or Fischer's exact option for categorical variables, depending on the conditions required. The adjusted odds ratios were calculated with their 95% confidence intervals. The statistical significance threshold was set at 5% ($p < 0.05$).

Multivariate logistic regression was used to identify factors independently associated with high cardiovascular risk.

2.10. Consent and Ethical Approval

Written consent was obtained from each participant before being registered and answering the survey questionnaire. The anonymity of the information collected was assured during the survey. As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

3. Results

3.1. Sociodemographic Data of Study Participants

Table 1 shows that the majority of respondents were young (aged between 30 and 39), illiterate or had a primary education, lived alone and had no occupation. Significant differences were found between male and female participants on several parameters. Additionally, men were on average older (44.5 ± 14.3 vs. 40.5 ± 13.1 years, $p = 0.002$), had higher educational attainment (8.2% vs. 5.7% at a higher

level, p = 0.001), and were more likely to be employed (62.1% vs. 57.6%, p < 0.001). A higher BMI mean was observed in women (27.5 ± 4.6 vs 25.9 ± 3.9, p < 0.001), along with higher HDL-cholestérol levels (1.4 ± 0.4 vs 1.2 ± 0.3, p < 0.001), but men had higher arterial pressure and triglyceride levels (Table 1).

Table 1. Socio-demographic and clinical characteristics of Study Participants in the city of Kisangani.

Characteristics	Total (n = 344)	Men (n = 148)	Women (n = 196)	p value
Age (years), mean ± SD	42.3 ± 13.7	44.5 ± 14.3	40.5 ± 13.1	0.002
Age groups, n (%)				0.006
30 - 39 years	155 (45)	73 (49.3)	100 (51)	
40 - 59 years	141 (40.9)	67 (46.8)	78 (39.7)	
≥60 years	48 (14.1)	8 (3.9)	18 (9.3)	
Level of education, n (%)				0.001
- Primary or less	230 (66.8)	95 (64.1)	135 (68.8)	
- Secondary	92 (26.7)	41 (27.7)	50 (25.5)	
- Superior	22 (6.5)	12 (8.2)	11 (5.7)	
Marital status, n (%)				0.017
- Lives alone	215 (62.5)	96 (64.8)	132 (67.3)	
- Lives with spouses	129 (37.5)	52 (35.2)	64 (32.7)	
Occupational status, n (%)				<0.001
- Working	223 (64.8)	92 (62.1)	113 (57.6)	
- Not working	121 (32.2)	56 (37.9)	83 (42.2)	
SBP (mmHg), mean ± SD	129.5 ± 5.7	130.7 ± 5.5	128.3 ± 6.0	<0.001
DBP (mmHg), mean ± SD	83.6 ± 4.3	84.5 ± 3.8	83.1 ± 4.5	0.001
BMI (kg/m²), mean ± SD	26.9 ± 4.2	25.9 ± 3.9	27.5 ± 4.6	<0.001
Waist circumference (cm), mean ± SD	89.4 ± 11.2	90.1 ± 9.9	88.7 ± 12.3	0.205
Fasting plasma glucose (mmol/L), mean ± SD	5.3 ± 1.4	5.5 ± 1.5	5.2 ± 1.4	0.154
Total cholesterol (mmol/L), mean ± SD	4.9 ± 1.2	4.7 ± 1.0	4.9 ± 1.1	0.062
LDL cholesterol (mmol/L), mean ± SD	2.8 ± 0.9	2.8 ± 0.8	3.0 ± 0.9	0.022
HDL-cholesterol (mmol/L), mean ± SD	1.2 ± 0.4	1.2 ± 0.3	1.4 ± 0.4	<0.001
Triglycerides (mmol/L), mean ± SD	1.4 ± 0.9	1.6 ± 0.9	1.3 ± 0.8	<0.001

SD: Standard deviation; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; BMI: Body Mass Index.

3.2. Prevalence of Cardiovascular Risk Factors

The prevalence of the primary modifiable cardiovascular risk factors in the research population is displayed in Figure 1.

The most common risk factors were being low physically active (58.6%), having dyslipidaemia (23.7%), being obese (10.6%), having diabetes (8.6%), and smoking (3.3%).

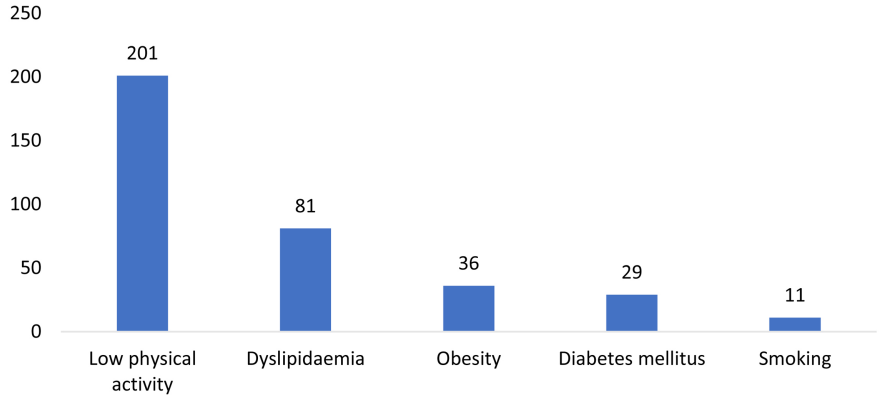

Figure 1. Prevalence of cardiovascular risk factors.

3.3. Assessment of Cardiovascular Risk According to ISH/WHO Score

Table 2 shows the distribution of 10-year global cardiovascular risk according to the WHO/ISH score.

Table 2. Distribution of global cardiovascular risk according to WHO/ISH score.

Level of risk	n (%)
Low (<10%)	173 (50.2)
Moderate (10% - 19%)	59 (17.1)
High (20% - 29.9%)	74 (21.5)
Very high (≥30%)	38 (11.2)

This table shows that a significant proportion of the participants in the study (32.7%) had a high or very high cardiovascular risk.

3.4. Factors Associated with High Cardiovascular Risk

Multivariate logistic regression analysis revealed that older age (AOR = 4.27; CI 95%: 2.59 - 7.06; p < 0.001), male sex (AOR = 1.86; CI: 1.14 - 3.02; p = 0.013), smoking (AOR = 2.41; CI 95%: 1.44 - 4.08; p = 0.001), low physical activity (AOR = 1.75; CI: 1.08 - 2.86; p = 0.025), diabetes mellitus (AOR = 3.92; CI: 1.78 - 8.77; p = 0.001), dyslipidaemia (AOR = 2.15; CI 95%: 1.32 - 3.50; p = 0.002) and obesity (AOR = 2.76; CI 95%: 0.93 - 2.53; p = 0.005) (Table 3).

Table 3. Factors associated with high cardiovascular risk in prehypertensive subjects in Kisangani (multivariate analysis).

Factors	AOR	CI 95%	p value
Age ≥ 50 years old	4.27	2.59 - 7.06	<0.001
Male sex	1.86	1.14 - 3.02	0.013
Smoking	2.41	1.44 - 4.08	0.001

Continued

Low physical activity	1.75	1.08 - 2.86	0.025
Diabetes mellitus	3.92	1.78 - 8.77	0.001
Dyslipidemia	2.15	1.32 - 3.50	0.002
Obesity	2.76	1.35 - 5.64	0.005

AOR: Adjusted Odds Ratio; CI: Confidence Interval.

4. Discussion

As far as we are aware, our study is the first to evaluate cardiovascular risk variables and overall cardiovascular risk in pre-hypertensive subjects in the northeastern DRC. According to the WHO/ISH score, a sizable fraction of participants (32.7%) had a high or very high cardiovascular risk at 10 years. This finding is in line with one of the few studies on the topic conducted in Africa, which found that Tunisian pre-hypertensives had a much higher risk (31.1%) of coronary heart disease within ten years (more than 15%) [13]. This is a concerning discovery that emphasises the need for a thorough cardiovascular risk assessment, especially in those who have not yet developed overt hypertension.

Prevalence of the main cardiovascular risk factors including low physical activity, dyslipidaemia diabetes mellitus, obesity, diabetes mellitus and smoking was high among study participants.

The observations can be ascribed to the ongoing epidemiological change in Kisangani, characterised by fast urbanisation and the embrace of Western, sedentary lifestyles.

These correlations are in line with the existing research on cardiovascular risk factors for PHTN, underscoring the necessity of a multifaceted approach to the prevention of cardiovascular illness [7] [14]-[18].

4.1. Older Age

According to this study, PHTN is significantly associated with older age as a cardiovascular risk factor (AOR = 4.27; CI 95%: 2.59 - 7.06; $p < 0.001$). The findings of Li G *et al*., Habib GB *et al*., and Jin Q *et al*. are consistent with this association [19]-[21]. Through intricate biological processes, such as vascular alterations, elevated inflammation, and risk factor clustering, advanced age increases the cardiovascular risk linked to PHTN.

4.2. Male Sex

Male sex has been identified as a significant cardiovascular risk factor for PHTN (AOR = 1.86; CI 95%: 1.14 - 3.02; $p = 0.013$). This finding is similar to several previous studies [21]-[23]. Male sex increases the cardiovascular risk of PHTN thanks to a combination of biological factors (such as arterial stiffness and the absence of oestrogens), behavioural factors (lifestyle) and inflammatory factors (elevated biomarkers). This highlights the importance of increased vigilance and earlier screening in men, even in the absence of other apparent risk factors.

4.3. Smoking

Smoking has emerged as a major risk for the cardiovascular system in relation to PHTN (AOR = 2.41; CI 95%: 1.44 - 4.08; p = 0.001). Smoking has been shown to be a significant risk for the cardiovascular system, particularly in relation to PHTN. This observation has been validated by other studies carried out in Japan, South Korea and Nepal [24]-[26]. These results are in line with current knowledge, which establishes that smoking constitutes a major risk to cardiovascular health due to its direct and indirect effects. This justifies the implementation of a targeted prevention strategy, incorporating smoking cessation and the management of other modifiable cardiovascular risk factors.

4.4. Low Physical Activity

Low physical activity is a high cardiovascular risk factor independent of PHTN in our study (AOR = 1.75; CI 95%: 1.08 - 2.86; p = 0.025). This is consistent with the work of Malik *et al.* and Kim *et al.* [7] [26]. A prevention strategy that incorporates physical activity and nutritional balance is justified because a sedentary lifestyle may actually be a high cardiovascular risk factor for PHTN due to the increased responses to psychological stress, systemic inflammation, decreased insulin sensitivity, and vascular dysfunction.

4.5. Diabetes Mellitus

Our study's findings showed a robust association between diabetes mellitus and high cardiovascular risk (AOR = 3.92, CI 95%: 1.78 - 8.77; p = 0.001) emphasise the significance of early detection and treatment of diabetes in prehypertensive individuals. The mechanisms behind this connection have been well-established in the literature and include oxidative stress, vascular inflammation, endothelial dysfunction, insulin resistance, chronic hyperglycemia, lipoprotein abnormalities, and improper hormonal system activation [27]-[30]. Given that most people in Kisangani lack access to quality diabetic treatment, the results of this study are very crucial for setting priorities for health resources.

4.6. Dyslipidaemia

This study found dyslipidaemia to be a significant risk factor for PHTN (AOR = 2.15, CI 95%: 1.35 - 5.64; p = 0.005).

Numerous processes, such as LDL oxidation, oxidative stress, atherosclerosis development, interaction with the renin-angiotensin-aldosterone system, and systemic inflammation, may be explained by this observation [31] [32]. The significance of including dyslipidaemia screening and therapy into cardiovascular disease preventive initiatives is underscored by this finding.

4.7. Obesity

As a significant cardiovascular risk factor in our study population, obesity is important (AOR = 2.76, CI 95%: 1.35 - 5.64; p = 0.005). This finding is consistent

with research by Dwivedi *et al*. and Khelil *et al*. [33] [34]. This finding necessitates the use of programs meant to encourage physical activity and dietary education.

4.8. Study Limitations

This study has several limitations that need to be acknowledged. First off, the results may not be as broadly applicable to the entire DRC due to the sample's small size and confinement to a single town. The second drawback of the cross-sectional methodology is that it is unable to establish causal relationships between the identified risk variables and elevated cardiovascular disease risk. To confirm our findings and assess the long-term impact of preventive strategies, larger longitudinal studies are necessary.

Despite these limitations, our study—pioneering in our discipline—provides essential insights into the cardiovascular characteristics of a minimally examined population.

It underscores the importance of adopting a proactive approach to avoid cardiovascular disease in individuals with PHTN, even in the absence of hypertension.

5. Conclusion

This study's ISH/WHO score indicates that a high prevalence (32.7%) of cardiovascular risk is present among Kisangani's pre-hypertensive population. The following factors have been independently linked to this increased risk: diabetes mellitus, obesity, dyslipidaemia, smoking, male sex, advanced age, and physical inactivity. These results underscore the importance of building targeted prevention strategies that prioritise lifestyle modification, risk factor management, and health education, as well as integrating comprehensive cardiovascular risk assessment into primary healthcare to reduce cardiovascular events among adults in Kisangani.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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