The Ten-Year Risk of Developing Cardiovascular Disease Among Public Health Workers In North-Central Nigeria Using Framingham And Atherogenic Index of Plasma Risk Scores

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Abstract

**Background:** Estimation of total cardiovascular disease (CVD) risk with the use of risk prediction charts such as the Framingham risk score and Atherogenic index of plasma score is a huge improvement on the practice of identifying and treating each of the risk factors such as high blood pressure and elevated blood cholesterol. The estimation of the total risk highlights that CVD risk factors occur together and thereby predicts who should be treated. There is scarcity of data on the risk scoring of adults in Nigeria including health workers. Therefore, this study was done to estimate the cardiovascular risks of health workers in public health services in north-central Nigeria.

**Methods:** A cross-sectional survey was performed using validated Framingham risk score calculator and calculation of risk based on the lipid profile of 301 randomly selected health workers in North-central Nigeria. Descriptive analysis was done using frequency counts and percentages while inferential statistics were done using chi square and correlation analyses using statistical Package for Social Sciences (SPSS) version 21.0. The confidence level was 95% and the level of significance was set at 0.05.

**Results:** The 10-year risk of developing CVD was generally low in the health workers. Using Framingham risk score, 98.3% of health workers have low risk, 1.0% have moderate risk and 0.7% have high risk. Among the cadres of health workers, 1.5% of the nurses have moderate risk while 2.5% of the doctors and 3.3% of the CHEWs have high risk of developing CVD in 10 years. Using Atherogenic index of plasma scoring, only 2% of the health workers have high risk, 4.7% have intermediate risk while 93.4% have low risk. Across the cadres, 6.3% of the nurses and 3.3% of the CHEWs have intermediate risk while 2.4% of the nurses and 3.3% of the CHEWs have high risk. These findings were however not statistically significant.

**Conclusions:** the 10-year risk of developing cardiovascular disease was low in the health workers in this study using both Framingham's risk score and atherogenic index of plasma scores.

**Background**

Cardiovascular disease (CVD) has become very common all over the world in both developing and developed nations, especially among adults.\(^1\) In Sub-Saharan Africa, the incidence has been rising steadily for many years.\(^2\) Cardiovascular diseases include stroke, coronary heart disease, aortic aneurysms and dissection, deep vein thrombosis, pulmonary embolism, etc.\(^3,4\)

Cardiovascular disease is not cause specific; it has both modifiable and non-modifiable risk factors. The morbidity and mortality from CVDs to a large extent is attributable to modifiable risk factors which were initially prevalent in the developed countries.\(^1,2\) The modifiable risk factors include but not limited to: physical inactivity, increased body mass index (BMI), high blood pressure, diabetes, high cholesterol level, tobacco use, unhealthy diet including high salt intake.\(^4-7\)

To assess the prevalence of cardiovascular risk, there are certain tests and behavioural factors to be considered. These also predict the likelihood of having CVD and determine whether the degree of risk is mild, moderate or severe. The assessment of CVD risk factors is done by taking history about behaviours and taking physical and biochemical measurements which are as a result of the individual’s behaviours.
In the developed countries, the risk assessment methods used are usually costly and effective. However use of these methods may not be possible in low income countries. Currently used in developing countries are CVD risk management tools developed by the World Health Organization (WHO). Estimation of total CVD risk with the use of risk prediction charts is a huge improvement on the practice of identifying and treating each of the risk factors such as high blood pressure and elevated blood cholesterol. The estimation of the total risk highlights that CVD risk factors occur together and thereby predicts who should be treated. An example of the risk score calculator is that used in the Framingham Heart Study.

One of the levels of prevention deals with early diagnosis and prompt treatment of risk factors of CVD. This is targeted at those with high risk of CVD. Screening methods used include physical measures such as weight and height check to determine the body mass index, fasting blood glucose for diabetes, fasting lipid profile for dyslipidaemia and blood pressure measurement for hypertension. Those with confirmed risks are then treated promptly and effectively. Drugs have shown to be very effective in the management of CVD and its risk factors. Early diagnosis and prompt treatment of cases has been shown to reduce mortality from stroke by 45%.

Estimation of risk of developing CVD can also be done by using the Framingham risk score chart and atherogenic index of plasma score. The Framingham risk score chart which is used to estimate the risk of developing CVD consists of seven variables. The variables are age, gender, total cholesterol, HDL cholesterol, smoking history, systolic blood pressure, diabetes mellitus as well as the current use of medication for the treatment of high blood pressure. The variables after computation into an application grades the risks as follows: low risk (Risk < 10%), moderate risk (Risk 10% to <20%), and high risk (Risk ≥20%).

Similarly, the atherogenic index of plasma (AIP) can also be used as an index for estimation CVD risk. The logarithmic calculation of the ratio of serum level of triglycerides to high density lipoproteins (HDL-C) is used to determine AIP. When individuals have deranged lipid profiles, they become prone to the risk of atherosclerosis and its complications. It is a better diagnostic tool than ordinary lipid profile results.

Health workers are a major group of professionals in the class of essential services all over the world. Their work determines the health of the society at large, therefore, they are critical to the maintenance of a healthy society. They work in both public and private health services and offer services in primary, secondary and tertiary health care facilities and research institutes. Health workers comprise of doctors, nurses, laboratory scientists and technicians, pharmacists and pharmacy technicians, community health extension workers and community health officers, radiographers, audiographers, nutritionists and other allied health workers.

The aim of the study is to describe and predicts the ten-year estimation of developing cardiovascular disease among health workers in public health services in north-central Nigeria using validated Framingham and atherogenic index of plasma scores.

**Methods**

**Study design and population**
The study is a cross-sectional study conducted in 2019 on the atherogenic index of plasma and Framingham risk scores of cardiovascular disease among public health workers in North-Central Nigeria with the use of risk estimation charts. The study was done following pre-testing at 10 randomly selected primary health centres (PHCs), one secondary health facility and one tertiary facility in North-central Nigeria. A total of 301 health workers were randomly selected using multi-stage sampling technique. All of them met the inclusion criteria and there was no dropout from the study. The inclusion criteria for the study were health workers who were trained in accredited institutions, working in public health facilities and who have spent a minimum of one year in service while the exclusion criteria were health workers with history of cardiovascular disease.

**Data Collection And Analysis**

Data was collected over a period of 1 month using the self-administered semi-structured questionnaire. Anthropometric and blood pressure measurements as well as blood samples for Fasting lipid profile and Fasting blood glucose following a 12-hour fast were also collected.

All measurements were done according to WHO standards. Following analysis of the samples, Atherogenic index of plasma (AIP) was determined by using logarithmic transformation of the ratio of triglyceride to high density lipoprotein, Log (Tg/HDL-C). The AIP scores 0.11, 0.11-0.24, and ≥ 0.24 were graded as low risk, intermediate and high risk respectively. Also, the Framingham risk score calculator was used to estimate each health worker’s risk of developing CVD. The calculator is an application available on Google playstore. The calculator utilizes the input of eight variables to arrive at a score. These variables which score and predict an individual’s 10-year risk of developing CVD are age, gender, total cholesterol, HDL cholesterol, smoking history, systolic blood pressure, diabetes mellitus as well as the current use of medication for the treatment of high blood pressure. After computation, the scores were categorized as follows: low risk (Risk < 10%), moderate risk (Risk 10% to <20%), and high risk (Risk ≥20%).

The data was then analyzed using Statistical Package for Social Sciences (IBM/SPSS) version 21. The Framingham and AIP risk scores were presented frequency tables, charts and graphs. Spearman’s correlation coefficient was used to determine the correlation between AIP and CVD risk factors. A confidence interval of 95% was used in this study and a p value of < 0.05 was considered as significant.

**Results**

The age of the respondents ranged between 21-58 years with a mean age (± SD) of 39.3 (± 8.30) years. More than half, 160 (53.2%) of the respondents were females. About two-thirds of the participants, 205(68.1%) were nurses and 201 (66.8%) work at the tertiary institution. Majority of the participants have either diploma or bachelors’ degree (42.9% respectively). The median income and interquartile range (IQR) in Naira per month was ₦152,000 (₦100, 000-250,000). (See Table 1).
**Table 1**

Socioeconomic characteristics of the health workers

| Socioeconomic characteristics     | Frequency (N=301) | %    |
|-----------------------------------|-------------------|------|
| **Age (years)**                   |                   |      |
| 21 – 30                           | 54                | 17.9 |
| 31 – 40                           | 115               | 38.3 |
| 41 – 50                           | 100               | 33.2 |
| 51 – 60                           | 32                | 10.6 |
| Mean (± SD)                       | 39.30 (± 8.30)    |      |
| Range                             | 22 – 58           |      |
| **Sex**                           |                   |      |
| Male                              | 141               | 46.8 |
| Female                            | 160               | 53.2 |
| **Cadre**                         |                   |      |
| Doctor                            | 41                | 13.6 |
| Nurse                             | 205               | 68.1 |
| Pharmacist                        | 9                 | 3.0  |
| CHEW/CHO                          | 30                | 10.0 |
| Laboratory Scientist/tech        | 16                | 5.3  |
| **Health Facility**               |                   |      |
| PHC                               | 27                | 9.0  |
| Secondary                         | 73                | 24.2 |
| Tertiary                          | 201               | 66.8 |
| **Level of education**            |                   |      |
| Diploma                           | 129               | 42.9 |
| Bachelors                         | 129               | 42.9 |
| Postgraduate                      | 43                | 14.2 |
| **Income (₦)**                    |                   |      |

The age of the respondents ranged between 21-58 years with a mean age of 39.3 years while the modal age group was 31-40 years. More than half, 160 (53.2%) of the respondents were females.

About two-thirds of the participants, 205 (68.1%) were nurses and 201 (66.8%) work at the tertiary institution. Majority of the participants have either diploma or bachelors’ degree (42.9% respectively). The median income in Naira per month was ₦152,000 with an interquartile range of ₦100,000-250,000.
Socioeconomic characteristics

| Frequency (N=301) | %  |
|------------------|----|
| ≤ 100,000        | 80 | 26.6 |
| 101,000 - 200,000| 128| 42.5 |
| 201,000 - 300,000| 60 | 19.9 |
| > 300,000        | 33 | 11.0 |
| Median           | 152,000.00 |
| Interquartile range | 100,000.00 – 250,000.00 |

The age of the respondents ranged between 21-58 years with a mean age of 39.3 years while the modal age group was 31-40 years. More than half, 160 (53.2%) of the respondents were females.

About two-thirds of the participants, 205 (68.1%) were nurses and 201 (66.8%) work at the tertiary institution. Majority of the participants have either diploma or bachelors’ degree (42.9% respectively). The median income in Naira per month was ₦152,000 with an interquartile range of ₦100,000 - 250,000.

The 10-year risk of developing cardiovascular disease among the health workers using Framingham risk score shows that only 0.7% of them have high risk, 1.0% have moderate risk, while 98.3% have low risk. Therefore, majority of the health workers have a low 10-year risk of developing cardiovascular disease. Likewise, using Atherogenic Index of Plasma scoring, 2% have high risk, 4.7% have intermediate risk, while 93.4% have low risk. (See Table 2). This also means that majority of the health workers have mild risk of developing CVD from dyslipidaemia.

| Framingham and Atherogenic Index of Plasma Risk score grading of the health workers. |
|---------------------------------|-----------------|---|---|
| Risk scoring                   | Frequency (N=301) | % |
| **Framingham risk score**      |                  |   |
| Low risk                       | 296              | 98.3 |
| Moderate risk                  | 3                | 1.0 |
| High risk                      | 2                | 0.7 |
| **Atherogenic Index of Plasma**|                  |   |
| Mild risk                      | 281              | 93.4 |
| Intermediate                   | 14               | 4.7 |
| High risk                      | 6                | 2.0 |

Following the grading of the Framingham risk scores, majority of the health workers, 296 (98.3%) have low 10-year risk of developing cardiovascular disease. Likewise, after grading the Atherogenic Index of Plasma scores, majority of the health workers, 281 (93.4%) have low risk of developing CVD from dyslipidaemia.

Among the different cadres of health workers, 97.5% of the doctors, 98.5% of the nurses, 100% of the pharmacists, 96.7% of the CHEWs and 100% of the Laboratory scientists/technicians have low 10-year risk of developing CVD using Framingham risk score. However, 1.5% of the nurses have moderate risk while 2.5% of the doctors and 3.3% of the CHEWs have high risk of developing CVD in 10 years. (See Figure 1). Using AIP scores, 100% of the doctors,
91.3% of the nurses, 100% of the pharmacists, 93.4% of the CHEWs and 100% of the laboratory scientists/technicians have low risk of AIP dyslipidaemia. However, 6.3% of the nurses and 3.3% of the CHEWs have intermediate risk while 2.4% of the nurses and 3.3% of the CHEWs have high risk. These findings were however not statistically significant. (See Table 3)

| Job cadre | Doctor | Nurse | Pharm | CHEW | Lab | Total | \( \chi^2 \) | p value |
|-----------|--------|-------|-------|------|-----|-------|----------|--------|
| Variable  | n (%)  | n (%) | n (%) | n (%)| n (%)| N     |          |        |
| T.C       |        |       |       |      |     |       |          |        |
| Optimal   | 15(36.6)| 69(33.7)| 2(22.3)| 16(53.3)| 10(62.5)| 112(37.2)| 11.235 Y | 0.188  |
| Borderline| 15(36.6)| 80(39.0)| 3(33.3)| 4(13.4)| 2(12.5)| 104(34.6)|          |        |
| High risk | 11(26.8)| 56(27.3)| 4(44.4)| 10(33.3)| 4(25.0)| 85(28.2)|          |        |
| HDL       |        |       |       |      |     |       |          |        |
| High risk | 1(2.4) | 16(7.8)| 0(0.0) | 2(6.7) | 3(18.8) | 22(7.3) | 4.128 Y  | 0.845  |
| Beneficial| 2(4.9) | 21(10.2)| 1(11.1)| 2(6.7) | 0(0.0) | 26(8.6) |          |        |
| LDL       |        |       |       |      |     |       |          |        |
| Optimal   | 30(73.2)| 150(73.2)| 8(88.8)| 21(70.0)| 12(75.0)| 221(73.4)| 3.199 Y  | 0.999  |
| Borderline| 6(14.6) | 26(12.7)| 1(11.1)| 6(20.0)| 2(12.5)| 41(13.6) |          |        |
| High risk | 5(12.2)| 29(14.2)| 0(0.0) | 3(10.0)| 2(12.5)| 40(13.0) |          |        |
| Triglyceride|       |       |       |      |     |       |          |        |
| Optimal   | 38(92.7)| 181(88.3)| 9(100.0)| 26(86.7)| 16(100.0)| 270(89.7)| 1.458 Y  | 0.993  |
| Borderline| 1(2.4) | 15(7.3)| 0(0.0) | 3(10.0)| 0(0.0) | 19(6.3) |          |        |
| High risk | 2(4.9) | 9(4.4)| 0(0.0) | 1(3.3) | 0(0.0) | 12(4.0) |          |        |
| AIP       |        |       |       |      |     |       |          |        |
| Mild risk | 41(100.0)| 187(91.3)| 91(100.0)| 28(93.4)| 16(100.0)| 281(93.4)| 3.160 Y  | 0.923  |
| Intermediate| 0(0.0)| 13(6.3)| 0(0.0) | 1(3.3)| 0(0.0) | 14(4.7) |          |        |
| High risk | 0(0.0) | 5(2.4)| 0(0.0) | 1(3.3)| 0(0.0) | 6(2.0) |          |        |

\( \chi^2 \): Chi square test; Y: Yates corrected Chi square; \(*\): p value <0.05; Pharm: Pharmacists; Lab: Laboratory scientist/technician

There was good knowledge of CVD risk factors among all (100%) of those with moderate and low risk of CVD using Framingham risk score grade, while only 287 (97%) of those with low risk have good knowledge. Also, 272
(96.8%) of those with mild AIP dyslipidaemia risk have good knowledge while all (100%) of those with intermediate and high risk have good knowledge. (See Table 4). Only 57 (19.3%) health workers with low Framingham 10-year risk of developing CVD had good practice. Also, 56 (19.9%) of those with mild AIP dyslipidaemia risk had good practice. However, these were not statistically significant. (See Table 5). There was no gender disparity in the risk estimation of the health workers as there was no statistically significant association between sex, Framingham risk score and atherogenic index of plasma (AIP) score. (See Table 6)

| Knowledge                                      | Good | Poor | Total | \( \chi^2 \) | p value |
|------------------------------------------------|------|------|-------|--------------|---------|
| Framingham risk score grade                    |      |      |       |              |         |
| Low risk                                       | 287  | 9    | 296   | 5.289\(^{Y}\) | 0.071   |
| Moderate risk                                  | 3    | 0    | 3     |              |         |
| High risk                                      | 2    | 0    | 2     |              |         |
| Atherogenic Index of Plasma                    |      |      |       |              |         |
| Mild risk                                      | 272  | 9    | 281   | 0.608\(^{Y}\) | 0.738   |
| Intermediate                                   | 14   | 0    | 14    |              |         |
| High risk                                      | 6    | 0    | 6     |              |         |

\( \chi^2 \): Chi square test; \(^{Y}\) Yates corrected Chi square.

There was no statistically significant association between good knowledge of cardiovascular disease and Framingham risk score and AIP dyslipidaemia risk score. (p>0.05)
Table 5
Relationship between practice of cardiovascular disease prevention and clinical risk

| Practice                              | Poor (%) | Fair (%)  | Good (%) | Total (%) | $\chi^2$ | p-value |
|---------------------------------------|----------|-----------|----------|-----------|---------|---------|
| **Clinical risk scores**              |          |           |          |           |         |         |
| Framingham                            |          |           |          |           |         |         |
| Low risk                              | 37 (12.5)| 202 (68.2)| 57 (19.3)| 296 (98.3)| 0.474   | 0.976   |
| Moderate risk                         | 0 (0.0)  | 2 (66.7)  | 1 (66.7) | 3 (1.0)   |          |         |
| High risk                             | 0 (0.0)  | 1 (50.0)  | 1 (50.0) | 2 (0.7)   |          |         |
| Atherogenic Index of Plasma           |          |           |          |           |         |         |
| Mild risk                             | 34 (12.1)| 191 (68.0)| 56 (19.9)| 281 (93.4)| 0.261   | 0.992   |
| Intermediate                          | 2 (14.3) | 10 (71.4) | 2 (14.3) | 14 (4.7)  |          |         |
| High risk                             | 1 (16.1) | 4 (66.7)  | 1 (16.7) | 6 (2.0)   |          |         |

$\chi^2$: Chi square test; Y: Yates corrected Chi square

There was no significant relationship between good CVD prevention practices and clinical risk scoring. (p values >0.05).
Table 6
Relationship between sex and clinical risk of the health workers

| Female | Male | Total | χ² | p value |
|--------|------|-------|----|---------|
| Variable | n (%) | n (%) | N (%) |    |         |
| Framingham risk score | | | | | |
| Low risk | 137 (97.2) | 159 (99.4) | 296 (98.3) | 3.293 | 0.176 |
| Moderate risk | 3 (2.1) | 0 (0.0) | 3 (1.0) | | |
| High risk | 1 (0.7) | 1 (0.6) | 2 (0.7) | | |
| AIP | | | | | |
| Mild risk | 130 (92.2) | 151 (94.4) | 281 (93.4) | 3.171 | 0.210 |
| Intermediate risk | 6 (4.3) | 8 (5.0) | 14 (4.6) | | |
| High risk | 5 (3.5) | 1 (0.6) | 6 (2.0) | | |

χ²: Chi square test; F: Fisher's exact test; t: Independent Samples T test

There is no statistically significant association between sex Framingham risk score and atherogenic index of plasma (AIP) score.

Although only 20 (6.7%) of the health workers had intermediate-high risk AIP dyslipidaemia, there was a positively higher correlation between AIP score and triglyceride (0.912) and this was significant at p value <0.001, while there was a negatively high correlation between AIP score and HDL cholesterol (-0.558) at p value of <0.001. AIP risk was also significantly positively correlated to BMI (0.118, p value 0.041), waist circumference (0.174, p value 0.002) and fasting blood glucose (0.182, p value 0.002); and negatively correlated to LDL cholesterol (-0.215, p value <0.001). (See Table 7 and figures 2-7)
Table 7
Correlation between Atherogenic Index of Plasma scores and CVD risk factors of respondents

| Risk factors         | r   | p value |
|----------------------|-----|---------|
| BMI                  | 0.118 | 0.041*  |
| Blood pressure       | -0.001 | 0.991   |
| SBP                  | 0.043 | 0.459   |
| DBP                  | -0.014 | 0.815   |
| Waist circumference  | 0.174 | 0.002*  |
| Total cholesterol    | -0.028 | 0.627   |
| HDL                  | -0.558 | <0.001* |
| LDL                  | -0.215 | <0.001* |
| Triglyceride         | 0.912 | <0.001* |
| Fasting blood glucose| 0.182 | 0.002*  |
| Framingham score     | 0.011 | 0.851   |

r: Spearman’s correlation coefficient rho; *: p value <0.05

Although only 20 (6.7%) of the health workers had intermediate-high risk AIP dyslipidaemia, there was a positively higher correlation between AIP score and triglyceride (0.912) and this was significant at P value <0.001, while there was a negatively high correlation between AIP score and HDL cholesterol (-0.558) at p value of <0.001. AIP risk was also significantly positively correlated to BMI (0.118, p value 0.041), waist circumference (0.174, p value 0.002) and fasting blood glucose (0.182, p value 0.002); and negatively correlated to LDL cholesterol (-0.215, p value <0.001).

Discussion

The study included respondents from age 22-58 years with mean age and standard deviation of 39.30 (± 8.30) years. This is similar to the study among health workers in Ghana (age range: 22-59 years, mean age:32.1 ± 8.9 years).16 About 56.1% of them were young, between age 21-40 years. This may be because they were a working population. This was lower than that reported in Ghana with the young population being 86.61%.16 More than half of the health workers were females, 160 (53.2%). This is because the study has a high nurses’ population, 205 (68.1%). This is consistent with other studies citing females being the dominant gender among nurses.19,20 This may also be due to the caring nature of women generally.

Two thirds of the participants, 201 (66.8%) work with tertiary facility. This is because the tertiary institution had the highest population of health workers in the study area. The median monthly income was ₦152,000 ($389.30). The interquartile range of monthly income was ₦100,000-250,000 ($256-640). This is consistent with the finding from a survey of the Nigerian middle class with earning between $480-645.21 This means than an average Nigerian health worker can afford basic amenities such as food and shelter.21
The 10-year risk of developing cardiovascular disease was low in the health workers. Majority (98.3%) of the respondents had low risk while only 0.7% had risk using the Framingham risk score. This is similar to the findings from the study among office workers in Iran in which 90.5% of the participants had low risk. There was also not much gender disparity in the Framingham risk estimation of the study participants as 99.4% of females and 97.2% of males had low risk. This is a contrast to the study in Iran in which there was a significant higher risk in males than females. Across the cadres of health workers, 97.5% of the doctors, 98.5% of the nurses, 100% of the pharmacists, 96.7% of the CHEWs and 100% of the laboratory scientists had low risk while only 1.5% of the nurses had moderate risk and 2.5% of the doctors and 3.3% of the CHEWs had high risk.

Atherogenic index of plasma (AIP) is an important marker for plasma atherogenicity which is used to predict CVD risk. In this study, 93.4% have mild risk, 4.7% have intermediate risk while 6% have high risk. Females have higher AIP scores than males which means that females have higher risk of CVD dyslipidaemia risk factors than males. This may be due to the sedentary nature of many women. Furthermore, this study revealed that there was a statistically significant positive correlation between AIP and BMI (r=0.118, p value 0.041), waist circumference (r=0.174, p value 0.002), triglyceride (r=0.912, p value <0.001) and fasting blood glucose (r=0.182, p value 0.002). This means that health workers with generalized obesity, visceral obesity, triglyceride dyslipidaemia and diabetes had high risk of AIP dyslipidaemia. There was also a statistically significant negative correlation between AIP and HDL (r=-0.558, p value <0.001) and LDL cholesterol (r=-0.215, p value <0.001). Therefore, health workers with high HDL and LDL cholesterol had low risk of AIP dyslipidaemia. This is corroborated by the findings in a study done among staff of a University in Malaysia which reported significant positive correlation between AIP and triglyceride (0.84, p<0.05); and negative correlation between AIP and HDL cholesterol (-0.72, p<0.05) with higher risks in females than males.

On the contrary, in an adult population in Iran, AIP risks were higher in males than females (r=-0.18, p<0.001). It also reported statistically significant positive correlation reported between AIP and triglyceride (r=0.77, p<0.001), LDL cholesterol (r=0.29, p<0.001), total cholesterol (r=0.2, p<0.001), fasting blood glucose (r=0.14, p<0.001) and both systolic (r=0.13, p<0.001) and diastolic blood pressures (r=0.16, p<0.001) with a negative correlation to HDL cholesterol (r=-0.72, p<0.001). Also, the study reported majority of the population to have high AIP risk. Although this study reports only 6% high risk of AIP dyslipidaemia, there is a need for this group of people to continually test for dyslipidaemia especially with the high prevalence of overweight and obesity.

**Limitation**

The limitation with the study was the design (cross-sectional study) which made it impossible to determine the temporal relationship between the study variables.

**Conclusions**

The 10-year risk of developing cardiovascular disease among health workers using Framingham and atherogenic risk scores was low in majority of the respondents. This study is offering a baseline data on the estimation of cardiovascular risk among health workers in North-central Nigeria.

**Abbreviations**
AIP: Atherogenic Index of Plasma
BMI: Body Mass Index
CHEWs: Community Health Extension Workers
CHOs: Community Health Officers
CVD: Cardiovascular Disease
CVDs: Cardiovascular Diseases
DBP: Diastolic Blood Pressure
FBG: Fasting Blood Glucose
HDL: High Density Lipoproteins
HDL-C: High Density Lipoproteins Cholesterol
IBM/SPSS: International Business Machines Corporation/Statistical Package for the Social Sciences/
IQR: Interquartile range
JNC: Joint National Committee
LDL: Low Density Lipoproteins
LDL-C: Low Density Lipoproteins Cholesterol
LICs: Low-Income Countries
LMICs: Low-and-Middle-Income Countries
NCDs: Non-Communicable Diseases
PE: Pulmonary Embolism
PHC: Primary Health Care/
SBP: Systolic Blood Pressure
SSA: Sub-Saharan Africa
TAG/Tg: Triglycerides/
TC: Total Cholesterol
WHO: World Health Organization

Declarations
Ethics approval and consent to participate

Ethical approval was obtained from the Ethical Review Committee of University of Ilorin Teaching Hospital with approval number ERC PAN/2018/11/1848. Before administration of the questionnaire and sample collection, the aim and benefits of the study were explained to each of the respondents and written informed consent was sought from them. During the data collection, all methods were performed in accordance with the World Health Organization standard guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

The data set for this study are available as supplementary material.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

OA was responsible for the conception and conceptualization and data analysis of the study. OA, BF, MA, BW and OM participated in the study design and data collection. OA and BF did data analysis and manuscript writing. OM and AB supervised the research work and manuscript writing. All authors read and approved the final manuscript.

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Figures

Figure 1

Framingham risk score of the health workers

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Figure 2

Correlation between AIP and BMI There was a weak positive correlation between AIP and BMI though not strong ($r=0.118$, $p$ value 0.041). This was statistically significant.
Figure 3

Correlation between AIP and systolic blood pressure. There was no correlation between AIP and systolic blood pressure ($r=0.043$, p value 0.459).
Figure 4

Correlation between AIP and HDL cholesterol. There was a strong negative correlation between AIP and HDL cholesterol (r=-0.558, p value <0.001). The correlation was statistically significant.
Figure 5

Correlation between AIP and LDL cholesterol. There was a weak negative correlation between AIP and LDL cholesterol ($r=-0.215$, p value <0.001). The correlation was statistically significant.
Correlation between AIP and triglyceride. There was a very strong positive correlation between AIP and triglyceride ($r=0.912$). The correlation was statistically significant at p value <0.001.

Figure 6
Figure 7

Correlation between AIP and Framingham risk score. There was no correlation between AIP and Framingham risk score (r= 0.011, p value 0.851).

Supplementary Files

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