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Distribution of Cardiovascular Risk Among Diabetic Patients in Kumasi

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Abstract: Cardiovascular diseases (CVDs) are the leading cause of mortality globally. Cardiovascular risk scores are reliable tools used to predict an individual's chance of developing a cardiovascular event. This study assesses the distribution of cardiovascular risk among diabetic patients attending a diabetic clinic in a district hospital in Kumasi. This is a hospital-based cross-sectional study among 94 diabetic patients attending a diabetic clinic in Kumasi, Ghana. Data collected includes sociodemographic information, anthropometry, medical history and lipid profile which were then used to compute the cardiovascular risk score using the pooled cohort equation (PCE) and WHO non-laboratory scoring tools. The average risk score was 13.5% [CI 95: 10.8 – 16.1] according to the PCE tool and 7.2% [CI 95: 6.2 – 8.1] according to the WHO non-laboratory risk scoring tool. The PCE categorised 52.1%, 25.5% and 22.3% as low, moderate and high risk respectively whiles the WHO non-lab categorised 78.7% and 21.3% as low and moderate risk respectively, with no one at high risk. Majority of our study participants were at low risk of developing a cardiovascular event in 10-years according to both tools. There was significant difference between the pooled cohort equation and WHO non-lab risk scoring calculators.

Keywords: Cardiovascular Risk, Pooled Cohort Equation, WHO Non-Laboratory, Diabetic Patients, Kumasi

1. Introduction

Myocardial infarction and stroke are the two commonest cardiovascular diseases in the world and they represent the leading cause of mortality worldwide [1]. In Ghana, the disease has moved from tenth to become the number one cause of mortality [2]. Stroke alone represents almost a tenth of all hospital admissions and is responsible for 13.2% of all adult deaths in Komfo Anokye Teaching Hospital in Kumasi [3].

The increase in incidence and prevalence of CVDs are mainly due to increase in prevalence of its risk factors. Hypertension, which was previously considered to be more prevalent in developed countries than developing ones, has now seen a change in that trend, with the reverse being the case [4]. In Africa, prevalence of hypertension has increased from less 5% of the population to more than a quarter within three decades [5]. Type 2 diabetes mellitus (T2DM), a very significant contributor to cardiovascular disease, is also showing a similar progression like hypertension in its distribution. The 2015 International Diabetes Federation report indicated approximately 7 million people with diabetes in Sub-Saharan Africa and projected that this number would be double by 2025 [6]. Hypertension is twice as prevalent in diabetics than the general population and the co-existence of the disease exponentially worsens the risk of developing a cardiovascular disease [7, 8].

Cardiovascular disease risk score assessment seek to predict the probability of an individual to develop a cardiovascular event. Different scoring systems rely on various parameters ranging from invasive procedures to non-invasive ones. Awareness of risk of developing a particular disease leads to positive behaviour patterns aimed at preventing the disease [8]. However most individuals rather have a lower perceived risk of future cardiovascular event [9]. An objective method of assessing risk is thus necessary to influence patients' health behaviour. Knowledge of CVD risk

scores not only affect patients' health behaviour and choices but also helps care providers to personalise management of their patients and tailor such managements based on their overall risks and not just their individual risk factors [10, 11]. This study assesses the distribution of cardiovascular risk among diabetic patients attending the diabetic clinic at a district hospital in Kumasi, Ghana.

2. Methods

2.1. Study Area

The study was conducted at the diabetic clinic of the Manhyia District Hospital. The Hospital is located at the Manhyia South sub-metro in Kumasi, Ghana. The sub-metro has a population of 424,552. The hospital serves all 53 communities in the sub-metro and also surrounding districts and municipalities. The diabetic clinic was run twice every week.

2.2. Study Population, Inclusion and Exclusion Criteria

The study population consisted of all patients who were regular attendants of the diabetic clinic at Manhyia District Hospital. Patients included in the study were those between the ages of 40 and 74 years and patients with a lipid profile within the last 6 months. Patients with a history of cardiovascular event (such as stroke, myocardial infarction, heart failure, peripheral artery disease) and those with missing values for any covariate were excluded.

2.3. Sample Size

Using the Cochran's formula, a sample size of 84 was computed [margin of error = 0.05, proportion of population at risk of CVD = 0.058 [12]]. A non-response rate of 15% was added, totaling 96 subjects. A convenient sampling method was used to recruit patients who met the inclusion criteria and visited the clinic within the study period till the desired sample size was attained.

2.4. Study Design and Data Collection

This was a hospital-based cross-sectional study. A data-capture sheet was used to information on socio-demographics, physical measurements, laboratory findings and patient co-morbidities. The following physical measurements were done: systolic and diastolic blood pressure, weight, height, hip circumference and waist circumference. The following laboratory findings were obtained: fasting blood sugar, urine protein, urine glucose, total cholesterol, HDL-c, LDL-c and triglyceride.

Body mass index was thereafter calculated by dividing weight (kg) by square of height (m^2). Waist-to-hip ratio (WHR) was computed for the patients by dividing waist circumference by hip circumference. Waist-to-height ratio (WHtR) was also calculated by dividing waist circumference by height.

2.5. Definitions

1) DM2 was defined as FBS $\geq$ 7 mmol/L and/or documented anti-diabetic medication. Hypertension denoted a mean BP $\geq$ 140/90 mmHg and/or documented anti-hypertensive treatment [13].
2) Increased serum triglycerides were defined as $\geq$ 1.695 mmol/L, increased total cholesterol as $\geq$ 5.17 mmol/L and decreased HDL-cholesterol as $\leq$ 0.9 mmol/L (male) or $\leq$ 1.0 mmol/L (female) [13-14].
3) Overweight and obesity were classified as BMI $\geq$ 25.0 kg/m^2, BMI $\geq$ 30.0 kg/ m^2 [15].

High waist circumference, high waist-to-hip ratio and high waist-to-height ratio were defined as 100cm, 0.96 and 0.57 respectively for men and 87cm, 0.85 and 0.54 respectively for women [16].

2.6. Total Cardiovascular Disease Risk Scoring

The 10-year CVD risk score was estimated using the WHO/ISH CVD risk non-laboratory-based chart (for Western Sub-Saharan Africa) and the Pooled Cohort Equation developed by the ACC/AHA (American College of Cardiology/American Heart Association). The WHO/ISH CVD risk non-laboratory-based chart combines age, sex, smoking status, body mass index (BMI) and systolic blood pressure to estimate the 10-year CVD risk whereas the Pooled Cohort Equation uses sex, age, race, smoking status, total cholesterol, HDL cholesterol, systolic blood pressure, use of antihypertensive medication and history of diabetes mellitus to compute an approximated 10-year risk for cardiovascular disease. Patients were then classified as being at 'low' (< 10%), 'moderate' (10% to 20%) and 'high' (> 20%).

2.7. Data Analysis

Data entry, validation and statistical analysis were done with STATA 14. Categorical data were summarized using frequencies and percentages whiles continuous data were summarized with mean and standard deviation. Pearson's correlation and chi-square were used to assess the association between anthropometric indices and the CVD risk scores. For all analyses p-values less than 0.05 were considered statistically significant.

2.8. Ethics and Consent

Ethical clearance was obtained from the Committee on Human Research Publication and Ethics (CHRPE) of the School of Medicine and Dentistry at Kwame Nkrumah University of Science and Technology, Kumasi. We sought permission from the Medical Superintendent of Manhyia District Hospital and as well as obtained verbal consent from individuals who agreed to participate in the study.

3. Results

3.1. Characteristics of Study Population

94 persons were included in the study. 84% were females. Mean age was 59.35 (SD=10.64).

Table 1. *Sociodemographic characteristics of Study Population.*

Variable	Overall (n=94)	Male (n=15)	Female (n=79)
Age (years), mean (SD)	59.35 (10.64)	62.33 (10)	58.78 (10.72)
Age group (years), n (%) <39	4 (4.3)	0 (0)	4 (5.1)
40 – 49	10 (10.6)	3 (20)	7 (8.9)
50 – 59	35 (37.2)	3 (20)	32 (40.5)
60 – 69	30 (31.9)	4 (26.7)	26 (32.9)
≥ 70	15 (16.0)	5 (33.3)	10 (12.7)
Religion			
Islam	31 (33.0)	3 (20)	28 (35.4)
Christian	63 (67.0)	12 (80)	51 (64.6)
Employment Status			
Employed	44 (46.8)	9 (60)	35 (44.3)
Unemployed	50 (53.2)	6 (40)	44 (55.7)
Level of Education			
None	33 (35.1)	0	33 (41.8)
Primary	10 (10.6)	1 (6.7)	9 (11.4)
JSS/Form 4	42 (44.7)	6 (40)	36 (45.6)
Sec School/O' Level	6 (6.4)	5 (33.3)	1 (1.3)
Tertiary	3 (3.2)	3 (20)	0

3.2. Summary of Anthropometric and Laboratory Measurements

Table 2 summarizes the anthropometric and laboratory findings of the study population. With regards to anthropometric measures and indices, no significant difference was noted between male and females.

Table 2. *Summary of Anthropometric and Laboratory Measurements.*

Variable	Female (n=79)	Male (n=15)	Overall (n=94)	p-value
Weight (kg),	72.0 [68.8 - 75.1]	68.4 [62.8 - 74.0]	71.4 [68.6 - 74.2]	0.175
Height (cm),	160.5 [157.4-163.6]	165.8 [158.9-172.7]	161.3 [158.5-164.1]	0.085
BMI (kg/m^2),	27.7 [26.5 - 29.0]	25.4 [23.4 - 27.3]	27.4 [26.3 - 28.4]	0.056
WC (cm),	102.5 [99.4-105.6]	109.4 [96.5 - 122.2]	103.6 [100.4-106.8]	0.06
HC (cm),	111.2 [108.2-114.2]	116.2 [103.6-128.7]	112.0 [108.9-115.1]	0.124
WHR	0.92 [0.906 – 0.941]	0.94 [0.885 - 1.003]	0.93 [0.91 – 0.944]	0.192
WHtR,	0.65 [0.62 – 0.67]	0.66 [0.58 – 0.75]	0.65 [0.62 – 0.67]	0.307
SBP (mmHg)	134.7 [131.9-137.5]	133.3 [126.2-140.5]	134.5 [131.9-137.0]	0.354
DBP (mmHg),	87.0 [84.7 – 89.3]	89.3 [83.2 – 95.4]	87.4 [85.2 – 89.5]	0.216
FBS (mmol/L),	9.3 [8.5 – 10.2]	7.7 [6.4 – 8.9]	9.1 [8.3 – 9.8]	0.052
T. Chol (mmol/L),	4.76 [4.48 – 5.03]	3.94 [3.37 – 4.50]	4.63 [4.38 – 4.88]	0.008
Triglycerides,	1.77 [1.70 – 1.85]	1.70 [1.51 – 1.88]	1.75 [1.69 – 1.82]	0.213
HDL-c (mmol/L),	1.56 [1.42 – 1.69]	1.26 [1.06 – 1.45]	1.51 [1.39 – 1.62]	0.031
LDL-c (mmol/L),	2.20 [1.98 – 2.42]	1.57 [1.17 – 1.98]	2.10 [1.90 – 2.30]	0.011

BMI-body mass index, FBS-fasting blood sugar, T. chol-total cholesterol, HDL-high density lipoprotein, LDL-low density lipoprotein, SBP-systolic blood pressure, DBP-diastolic blood pressure, WC-waist circumference, HC-hip circumference, WHR-waist-to-hip ratio, WHtR-waist-to-height ratio

Summary of laboratory findings are also show in Table 2. Overall, females had significantly higher mean total cholesterol, HDL-cholesterol and LDL-cholesterol.

3.3. Prevalence of Risk Factors

Table 3. *Prevalence of CVD Risk Factors.*

Variable	Female (n=79)	Male (n=15)	Overall (n=94)	p-value
Hypertension, n (%)	72 (91.1)	14 (93.3)	86 (91.5)	0.78
Smoking, n (%)	2 (2.5)	0	2 (2.1)	0.533
Overweight, n (%)	26 (32.9)	8 (53.3)	34 (36.2)	0.100
Obesity, n (%)	26 (32.9)	1 (6.7)	27 (28.7)	0.100
High WC, n (%)	71 (89.9)	9 (60)	80 (85.1)	0.003
High WHR, n (%)	66 (83.5)	5 (33.3)	71 (75.5)	<0.001
High WHtR, n (%)	71 (89.9)	10 (66.7)	81 (86.2)	0.017

Variable	Female (n=79)	Male (n=15)	Overall (n=94)	p-value
Hyperglycaemia, n (%)	54 (68.4)	9 (60)	63 (67.0)	0.528
High T. Chol, n (%)	30 (38.0)	2 (13.3)	32 (34.0)	0.065
Low HDL-c, n (%)	6 (7.6)	5 (33.3)	11 (11.7)	0.004
High LDL-c, n (%)	6 (7.6)	0	6 (6.4)	0.270
High Triglyceride, n (%)	47 (59.5)	6 (40)	53 (56.4)	0.163

From Table 3, 91.5% were hypertensive. Only 2 people were former smokers, and none was currently smoking. 36.2% and 28.7% of the sample were overweight and obese respectively. 85.1%, 75.5 and 86.2% had high WHR, high WHtR and high WC which were all significantly more prevalent in women than men. Regarding dyslipidemia, 34% had high total cholesterol, 11.7% had low HDL-cholesterol, 6.4% had high LDL-cholesterol and 56.4% had high triglycerides. HDL-cholesterol showed significant difference between men and women.

3.4. Total 10-Year CVD Risk Prediction

Table 4 shows the cardiovascular risk prediction by the pooled cohort equation and non-laboratory WHO/ISH calculators. According to the non-lab WHO risk score chart, 78.7% of the participants had low risk, 21.3% had moderate risk and none had high risk of developing a cardiovascular event in 10 years. However, the PCE classified 52.1% as low risk, 25.5% as moderate risk and 22.3% as high risk.

Table 4. *Total 10-year CVD Risk.*

10-year CVD Risk	Non-Laboratory (%, [CI 95])	PCE Score (%, [CI 95])
Low	78.7 [69.1 – 85.6]	52.1 [41.9 – 62.1]
Moderate	21.3 [14.0 – 30.9]	25.5 [17.6 – 35.5]
High	0	22.3 [14.9 – 32.0]

From Table 5 the mean score according to the PCE calculator and WHO/ISH non-laboratory chart was 13.5% [CI 95: 10.8 - 16.1] and 7.2% [CI 95: 6.2 - 8.1] respectively. Mean PCE score was significantly higher than mean WHO score, p-value < 0.001.

Table 5. *Mean CVD Risk Scores.*

Risk Calculator	Combined Mean,% [CI 95]	Male,% [CI 95]	Female,% [CI 95]
PCE score	13.5 [10.8 – 16.1]	22.4 [15.0 – 29.8]	11.8 [9.1 – 14.5]
WHO score	7.2 [6.2 – 8.1]	9.3 [6.8 – 11.8]	6.8 [6.0 – 7.7]
p-value	<0.001		

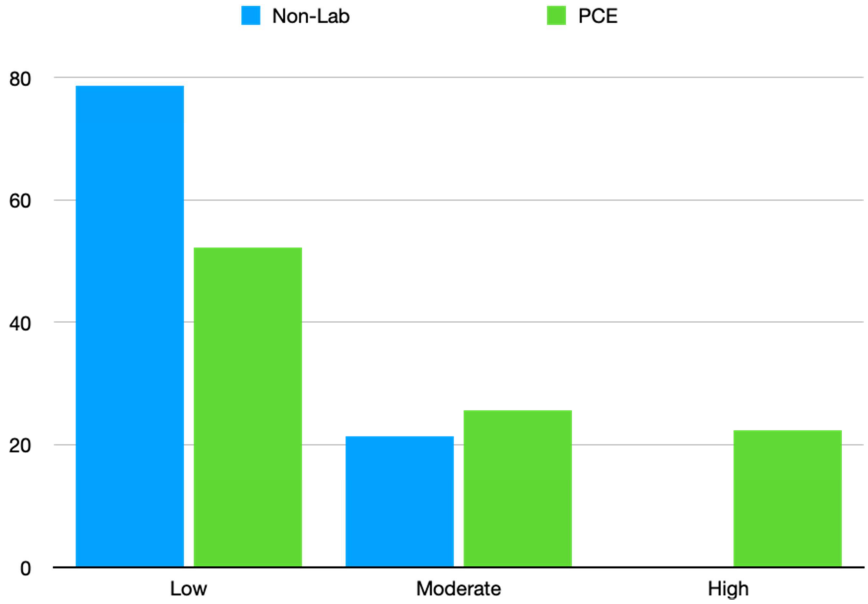

Figure 1. *Prediction of CVD Risk.*

4. Discussion

Cardiovascular diseases are the top causes of death in the world [1]. IN Ghana, CVDs account for over 13% of adult medical admissions thus being the number one cause of death in adults [2-3]. A lot of individuals underestimate their risk of developing cardiovascular disease [9]. Behaviors targeted

at managing risk factors and preventing CVD is highly influenced by awareness of patients' risk of the disease [17]. Cardiovascular diseases continue to plague people who are not assessed adequately or experience subclinical illness leading unrecognized disease. This is particularly observed in resource-scarce areas and remote geographical locations. The aim of the study was to assess the 10-year cardiovascular risk of patients attending the diabetes clinic of Manhyia District Hospital. The Pooled Cohort Equation and WHO/ISH non-lab algorithms were used to assess the CVD risks.

Hypertension, high waist-to-height ratio and high waist circumference were the top three risk factors respectively. Hypertension was highly prevalent among the study population as has been seen in other studies where up to 84% of the participants were hypertensive [18]. Hypertension has been identified as the leading associated risk factor for cardiovascular disease [19]. Central obesity as defined by high WHtR, high WC and high WHR together were second to hypertension similar to a study conducted in KATH even though the prevalence rate of central obesity in that study was considerably lower than this current study [20]. Prevalence of central obesity was significantly higher in females than males which is consistent with people of African descent in a Suriname. In both studies, prevalence of central obesity for the African female population was over 80% [21]. In this study, prevalence of overweight and obesity per BMI were 36.2% and 28.7% respectively compared to 24% and 46% from similar study. Though the overall prevalence of high BMI (>25kg/m^2) is close the prevalence rate of overweight and obesity is somewhat reversed and this could be partly explained by the older average age of this current study's population [22]. Smoking was the least prevalent risk factor similar to other studies carried out in Japan and among Ghanaians living in Europe and Ghana [23-24]. Smoking is generally low among Ghanaians even when compared to other African countries [25]. In this study, proportion of participants who had hyperglycemia was almost double what was recorded in a study among diabetics in Tamale. This indicates poorer glycemic control among this study population [26].

The study found that majority of the population were at low risk for both risk scores. This is contrary to a similar study conducted in KATH that used FRS in which majority of patients were in the moderate to high risk categories [27]. Considering studies that used multiple risk scoring systems, it was found that the FRS usually classified individuals into higher risk groups compared to the PCE that was used in this study hence not surprising that majority of the participants in the study conducted in KATH, though within the same geographical area as this study, had more patients at higher risk of CVD than this study found [28]. This is also seen in a different study where the average CVD risk score for the population was higher when the FRS was used compared to the PCE [29]. However other researchers have gotten results consistent with what this study found using the PCE scores where majority of the patients were at low risk of developing CVD within the next 10 years [30]. The RODAM study, that also used the PCE like this study, found 65% of the Ghanaian population living in Europe and Ghana to be at low risk compared to 52% observed in this study. It is worth noting that in the RODAM study, the cut-off score for classification into "low risk category" was score less than 7.5% as opposed to 10% or less in this study [24]. Another study that used the PCE to evaluate risk in Ghanaians and designated individuals into "low", "moderate" and "high" categories employing same cut-offs as was used in this this found that only 5.8% of the population living in Ghana and 6.8% of the population in Europe were at high risk considerably lower than the 22.3% recorded in this study. This could partly be explained by the older mean age (59.4 years) of this population as against the mean age of 52 years in that study [12]. The non-laboratory WHO/ISH score categorized a great majority (78.7%) of the participants as being at low risk of CVD with the remainder in the moderate risk category. No one had a WHO non-lab score more than 20%. This finding is not unusual with the WHO/ISH scoring system. A similar study conducted in middle east only identified 0.4% of the study population as being at high risk of CVD [31]. This proportion is very close to what is observed in this study. More studies that made use of region-specific WHO/ISH charts in LMICs in Asia and the Caribbean observed that about 90% of the study population were in the "low risk" category per the charts [27, 32, 33].

5. Conclusion

Cardiovascular diseases are the major complications of diabetes mellitus. In addition to diabetes, there are several other risk factors that contribute the development of CVDs.

Hypertension was the most prevalent risk factor.

Prediction of one's total cardiovascular risk depends on various research-based algorithms that are developed to give a score that estimates the probability of a person experiencing a cardiovascular event in the next 10 years. This study made use of a non-laboratory-based and a laboratory-based risk estimators to calculate the risk scores of the participants. Results from both algorithms showed that majority of the diabetic patients attending the diabetic clinic at Manhyia District Hospital were at low risk of developing a cardiovascular disease in the next 10 years.

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