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Research Article

DIAGNOSTIC ACCURACY OF THE WHO LABORATORY-BASED CARDIOVASCULAR RISK CHART IN DETECTING CARDIOVASCULAR DISEASE AT DR. SITANALA GENERAL HOSPITAL

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KEYWORDS

Cardiovascular disease
WHO chart
Risk
Sensitivity
Specificity
Validity
Accuracy

ABSTRACT

Cardiovascular disease is the leading cause of death worldwide. The World Health Organization (WHO) laboratory-based Cardiovascular Risk Chart was developed as a screening tool to estimate the 10-year risk of cardiovascular events; however, its validity in Indonesia remains unclear. This study aimed to evaluate the accuracy of the chart and to analyze the association between risk factors—age, sex, smoking status, systolic blood pressure, total cholesterol levels, and diabetes mellitus status—and the occurrence of cardiovascular disease. This was a quantitative study with a cross-sectional design using secondary data from outpatient medical records at Dr. Sitanala Central General Hospital from January 2024 to March 2025, involving 210 respondents. Data were analyzed using univariate analysis, chi-square test, and diagnostic test analysis with receiver operating characteristic (ROC) curves. The results showed that 51% of respondents had cardiovascular disease. The area under the curve (AUC) was 0.564 (p = 0.107; 95% CI: 0.487–0.642), indicating poor discriminative ability. Sensitivity was 66.36% and specificity was 41.75%. There were significant associations between sex, smoking status, and total cholesterol levels with cardiovascular disease (p < 0.05). In conclusion, the WHO laboratory-based Cardiovascular Risk Chart demonstrated low predictive accuracy in detecting cardiovascular disease in this population.

Kata Kunci

Penyakit kardiovaskular
WHO chart
Risiko
Sensivitas
Spesifitas
Validitas
Akurasi

ABSTRAK

Penyakit kardiovaskular merupakan penyebab utama kematian di seluruh dunia. Chart Risiko Kardiovaskular Organisasi Kesehatan Dunia (WHO) berbasis laboratorium dikembangkan sebagai alat skrining untuk memperkirakan risiko kejadian kardiovaskular dalam sepuluh tahun, namun validitasnya di Indonesia masih perlu dievaluasi. Penelitian ini bertujuan untuk menilai akurasi chart tersebut serta menganalisis hubungan faktor risiko, meliputi usia, jenis kelamin, status merokok, tekanan darah sistolik, kadar kolesterol total, dan status diabetes melitus, dengan kejadian penyakit kardiovaskular. Penelitian ini merupakan studi kuantitatif dengan desain potong lintang menggunakan data sekunder rekam medis rawat jalan di Rumah Sakit Umum Pusat Dr. Sitanala periode Januari 2024 hingga Maret 2025 dengan jumlah sampel 210 responden. Analisis dilakukan secara univariat, uji chi-square, serta uji diagnostik menggunakan kurva receiver operating characteristic (ROC). Hasil penelitian menunjukkan bahwa 51% responden mengalami penyakit kardiovaskular. Nilai area under the curve (AUC) sebesar 0,564 (p = 0,107; IK 95%: 0,487–0,642) menunjukkan kemampuan diskriminasi yang rendah. Sensitivitas sebesar 66,36% dan spesifisitas 41,75%. Terdapat hubungan bermakna antara jenis kelamin, status merokok, dan kadar kolesterol total dengan kejadian penyakit kardiovaskular (p < 0,05). Disimpulkan bahwa Chart Risiko Kardiovaskular WHO berbasis laboratorium memiliki kemampuan prediksi yang rendah dalam mendeteksi penyakit kardiovaskular pada populasi ini.

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INTRODUCTION

Cardiovascular disease (CVD) encompasses a range of disorders affecting the heart and blood vessels, including hypertension, coronary heart disease, stroke, heart failure, and various vascular disorders. It represents the foremost cause of mortality globally, accounting for approximately 17.9 million deaths annually or nearly 32% of all deaths worldwide (Galvan, 2024). Projections indicate that this trend will persist, potentially escalating to 23.6 million deaths by the year 2030 (Greenfield & Snowden, 2019). In Indonesia, the 2023 Indonesian Health Survey documented 877,531 cases of heart disease, with Banten Province notably ranking fifth with 38,751 recorded cases.

The ramifications of CVD extend beyond individual health outcomes, imparting a significant burden on the national health system and economy. Data from the Social Security Agency (BPJS Kesehatan) for 2024 reveal that heart disease claims accounted for the highest costs, exceeding 19 trillion rupiah for 22 million cases. This economic burden encompasses the expenses associated with medical treatment, inpatient care, and long-term therapy, in addition to adversely affecting the productivity of both patients and their families (CNN Indonesia, 2024). Complications arising from CVD, including heart failure, stroke, and myocardial infarction, not only diminish quality of life but also contribute to disability and persistent psychosocial stress (Akif et al., 2024; Slavin et al., 2021).

Early detection is a critical strategy for mitigating the progression of CVD. One method employed globally is the WHO Cardiovascular Risk Chart, which exists in two formats: Non-Laboratory Based and Laboratory Based. The Laboratory-Based version incorporates six key variables: age, sex, systolic blood pressure, smoking status, total cholesterol level, and diabetes mellitus status. This tool estimates the 10-year risk of cardiovascular events and categorizes outcomes into five risk categories: very low (<5%), low (5–10%), moderate (10–20%), high (20–30%), and very high (≥30%) (Das et al., 2022; Dehghan et al., 2023).

Notably, the validity of the WHO scale has yet to be assessed within the Indonesian context. This scale was developed utilizing global population data, whereas CVD risk factors may vary significantly across different populations due to influences such as genetics, dietary patterns, lifestyle habits, and healthcare infrastructures (Shreffler & Huecker, 2023; Marselin, 2024). Southeast Asian nations that have participated in the validation of this scale include Laos, Vietnam, Sri Lanka, and the Maldives; however, Indonesia was excluded from these trials (WHO CVD Risk Chart Working Group, 2019). The precision of risk prediction is, therefore, highly contingent upon the characteristics of the local population.

Research conducted by Kasim et al. (2023) in Malaysia revealed that the predictive accuracy of the WHO Risk Chart Laboratory-Based achieved an Area Under the Curve (AUC) of 0.72, indicating moderate efficacy in distinguishing CVD cases. An AUC value below 0.80 suggests limited clinical applicability of this instrument. Consequently, it is imperative to examine the validity of the WHO scale within the Indonesian population to ensure its effective application in clinical practice and public health policy.

In light of this context, the present study endeavors to evaluate the accuracy of the WHO Cardiovascular Risk Chart Laboratory-Based in predicting cardiovascular disease events among patients undergoing examinations at Dr. Sitanala General Hospital. The findings of this investigation are anticipated to furnish a scientific basis for the implementation of the WHO scale in healthcare settings throughout Indonesia.

MATERIALS AND METHODS

Instruments, Materials, and Samples

This study constitutes a quantitative observational investigation characterized by a cross-sectional design, conducted at Dr. Sitanala General Hospital in Tangerang during the period of March to April 2025. The data were obtained from patient medical records covering the timeframe from January 2024 to March 2025. The study population comprised all patients undergoing cardiovascular metabolic assessments, with samples selected utilizing consecutive sampling techniques in accordance with specified inclusion criteria (ages 40–74 years and complete data for the WHO scale) and exclusion criteria (history of terminal illness), in order to achieve a minimum of 136 respondents as determined through the evaluation of diagnostic area under the curve (AUC). The risk of cardiovascular disease was evaluated utilizing the WHO Cardiovascular Risk Chart Laboratory Based, incorporating variables such as age, sex, systolic blood pressure, smoking status, total cholesterol levels, and diabetes status; a physician's diagnosis of cardiovascular disease (CVD), including myocardial infarction, stroke, unstable angina, or heart failure, served as the gold standard. The data analysis incorporated diagnostic tests (sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratio, and AUC), as well as an examination of the relationship between risk factors and CVD events through the calculation of the Prevalence Ratio (PR) and the 95% confidence interval.

RESULT AND DISCUSSION

The attributes of cardiovascular disease risk factors within the sample examined in this study encompassed gender, age, smoking status, diabetes mellitus (DM) status, systolic blood pressure (SBP), and total cholesterol levels. Comprehensive data are presented below:

Table 1 Frequency Distribution of Respondent Characteristics According to Cardiovascular Disease Risk Factors at the Outpatient Polyclinic of Dr. Sitanala General Hospital for the Period of January 2024 to March 2025 (n = 210)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	106	50,5
	Female	104	49,5
	Total	**210**	**100**
Age	≥ 60 tahun	103	49,0
	< 60 tahun	107	51,0
	Total	**210**	**100**
Smoking Status	Smoker	103	49,0
	Non-Smoker	107	51,0
	Total	**210**	**100**
Diabetes Mellitus (DM) Status	Diabetes Mellitus	119	56,7
	Non-Diabetes Mellitus	91	43,3
	Total	**210**	**100**
Systolic Blood Pressure	≥ 140 mmHg	88	41,9
	< 140 mmHg	122	58,1
	Total	**210**	**100**
Total Cholesterol	≥ 5 mmol/L	130	61,9
	< 5 mmol/L	80	38,1
	Total	**210**	**100**

According to the data presented in Table 1, the characteristics of respondents classified within the high-risk group for cardiovascular disease reveal that 106 respondents (50.5%) were male, 103 respondents (49.0%) were aged ≥60 years, and 103 respondents (49.0%) exhibited a smoking habit. Additionally, a total of 119 respondents (56.7%) had a documented history of diabetes mellitus, 88 respondents (41.9%) demonstrated systolic blood pressure levels of ≥140 mmHg, and 130 respondents (61.9%) had total cholesterol levels of ≥5 mmol/L. These findings suggest that a majority of respondents possessed one or more significant risk factors that may contribute to the development of cardiovascular disease.

The distribution of cardiovascular disease (CVD) events, as determined by physician diagnoses documented in medical records, is illustrated in the subsequent table:

Table 2 Frequency Distribution of Cardiovascular Disease Events in Patients at the Outpatient Clinic of Dr. Sitanala General Hospital, January 2024 - March 2025 (n = 210)

Incidents of CVD	Frequency (n)	Percentage (%)
Non-CVD	103	49,0
CVD	107	51,0
Total	**210**	**100**

According to the data presented in Table 2, out of the 210 respondents, 107 (51.0%) were identified as having cardiovascular disease (CVD), while 103 (49.0%) were classified as not experiencing CVD (non-CVD). This result suggests that the incidence of cardiovascular disease was marginally higher among the respondents in this study compared to those without CVD, indicating a relatively balanced distribution.

The subsequent table delineates the distribution of predicted cardiovascular disease risk based on the WHO Cardiovascular Risk Chart (Laboratory Based) score:

Table 3 Frequency Distribution of Predicted CVD Risk Based on the WHO Cardiovascular Risk Chart (Laboratory Based) in Patients at the Outpatient Clinic of Dr. Sitanala General Hospital, January 2024 - March 2025 (n = 210)

WHO Score	Frequency (n)	Percentage (%)
<5%	21	10,0
5% to < 10%	58	27,6
10% to < 20%	95	45,2
20% to < 30%	26	12,4
≥ 30%	10	4,8
Total	**210**	**100**

According to Table 3, a significant proportion of respondents fell within the moderate risk category for cardiovascular disease events, characterized by a WHO score ranging from 10% to less than 20% (95 individuals, 45.2%). This finding suggests that nearly half of the patient population is assessed to be at moderate risk of experiencing a cardiovascular event within the next decade.

Furthermore, an examination of the distribution of predicted cardiovascular disease risk, as determined by the WHO Risk Charts and involving various risk factors such as gender, age, smoking status, diabetes mellitus, systolic blood pressure, and total cholesterol levels, was conducted utilizing the chi-square test. The outcomes of this analysis are detailed in Table 4 below:

Table 4 Analysis of the Relationship between Risk Factors and Cardiovascular Disease Events Based on Chi-Square Analysis in Patients at the Outpatient Clinic of Dr. Sitanala General Hospital, January 2024 - March 2025 (n = 210)

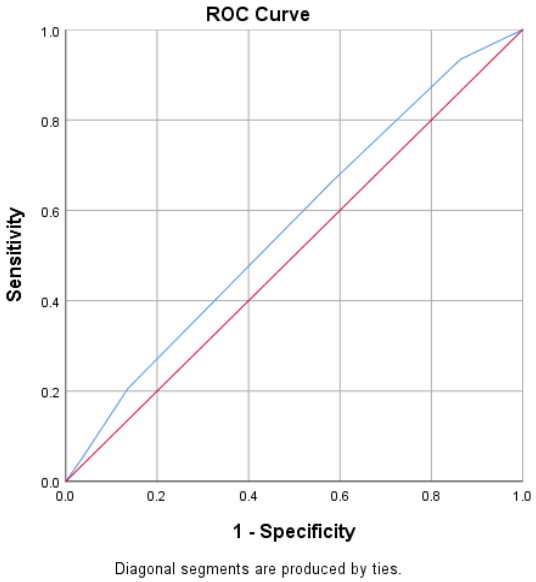
Risk Factor	CVD (n = 107)	Non-CVD (n = 103)	p-*value*	*PR* (95% CI)
Gender				
Male	66 (62,3%)	40 (37,7%)	0,002	1,58 (1,19 – 2,09)
Female	41 (39,4%)	63 (60,6%)		
Age				
≥ 60 tahun	52 (50,5%)	51 (49,5%)	1,000	0,98 (0,75 - 1,28)
< 60 tahun	55 (51,4%)	52 (48,6%)		
Smoking Status				
Smoker	65 (63,1%)	38 (36,9%)	0,001	1,61 (1,22 - 2,12)
Non-smoker	42 (39,3%)	65 (60,7%)		
Diabetes Mellitus Status				
DM	62 (52,1%)	57 (47,9%)	0,809	1,05 (0,80 - 1,38)
Non-DM	45 (49,5%)	46 (50,5%)		
Systolic Blood Pressure				
≥ 140 mmHg	43 (48,9%)	45 (51,1%)	0,708	0.93 (0,71 - 1,22)
< 140 mmHg	64 (52,5%)	58 (47,5%)		
Total Cholesterol			0,028	0.73

≥ 5 mmol/L	58 (44,6%)	72 (55,4%)	(0,56 - 0,94)
< 5 mmol/L	49 (61,3%)	31 38,8%)	

Bivariate analysis utilizing the Chi-Square test revealed that, among the six variables examined, three displayed a statistically significant association with the incidence of cardiovascular disease (CVD). Specifically, gender, smoking status, and total cholesterol levels exhibited significant correlations with CVD incidence (p=0.002, p=0.001, and p=0.028, respectively). The analysis indicated that men experienced a 1.58-fold increased risk of CVD compared to women (PR=1.58; 95% CI: 1.19–2.09), while active smokers presented a 1.61-fold higher risk relative to nonsmokers (PR=1.61; 95% CI: 1.22–2.12). Notably, an atypical outcome was observed concerning the cholesterol variable, where a cholesterol level of ≥5 mmol/L was associated with a protective effect against CVD incidence (PR=0.73; 95% CI: 0.56–0.94).

In contrast, age (p=1.000), diabetes mellitus status (p=0.809), and systolic blood pressure ≥140 mmHg (p=0.708) did not demonstrate a statistically significant association with CVD events. Although clinically, these three factors are generally linked to an increased risk of heart disease, the findings of this study suggest that, within the study population, there existed no statistically significant difference between high- and low-risk groups regarding CVD occurrences. These results necessitate further multivariate analysis or additional testing to identify potential confounding factors.

Figure 1. ROC Curve of the WHO Cardiovascular Risk Chart



The laboratory-based Receiver Operating Characteristic (ROC) curve analysis of the WHO Cardiovascular Risk Chart revealed an Area Under the Curve (AUC) of 0.564, accompanied by a p-value of 0.107 (95% CI: 0.487–0.642). The AUC value, which approximates 0.5 and is not statistically significant (p > 0.05), suggests that the discriminatory capacity of this scale in differentiating between patients with and without cardiovascular disease is limited. Consequently, the WHO Risk Chart laboratory-based utilized in this study did not exhibit sufficient predictive performance within the analyzed population.

Table 5 Sensitivity, Specificity, and Youden Index Values at Various Cut-Off Points of the WHO Cardiovascular Risk Chart (Laboratory Based)

Cut-off	**Sensitivity (%)**	**Specificity (%)**	***Youden Index***
1,50	100,0	0,0	0,00
5,00	93,5	13,6	0,071

Cut-off	**Sensitivity (%)**	**Specificity (%)**	***Youden Index***
11,25	66,4	41,7	0,081
20,00	20,6	86,4	0,070
30,00	5,6	96,1	0,017
36,00	0,0	100,0	0,00

The analytical results indicate that the optimal cut-off point for the WHO Cardiovascular Risk Chart (Laboratory Based) is 11.25, yielding a sensitivity of 66.4% and a specificity of 41.7%. This cut-off point generates the highest Youden Index value of 0.081, thereby rendering it the most balanced for distinguishing between patients with and without cardiovascular disease. Although a cut-off of 5.00 exhibits a very high sensitivity of 93.5%, its accompanying specificity is markedly low at 13.6%, rendering it suboptimal for practical application. In contrast, a cut-off of 11.25 lies within the moderate risk score range (10–<20%) as defined by the WHO classification and provides the most effective overall diagnostic performance in this study population.

Table 6 WHO Cardiovascular Risk Chart Laboratory-Based Diagnostic Analysis (Cut-off 10% - <20%)

Index Test	**Gold Standard (Physician Diagnosis)**		
	Positive (CVD)	**Negative (Non-CVD)**	**Total**
WHO Score(+)	71[a]	60[b]	**131**
Skala Score (-)	36[c]	43[d]	**79**
Total	**107**	**103**	**210**

Note: a (*True Positive*); b (*False Positive*); c (*False Negative*); d (*True Negative*)

Table 7 WHO Cardiovascular Risk Chart Laboratory-Based Diagnostic Performance (Cut-off 10% - <20%)

Parameter	**Value**
Sensitivity	66,36%
Specificity	41,75%
PPV	54,20%
NPV	54,43%
LR+	1,139
LR-	0,806
Accuracy	54,3%

Note: 1) PPV: *Positive Predictive Value;* 2) NPV: *Negative Predictive Value*; 3) LR+: *Likelihood Ratio Positive;* 4)LR-: *Likelihood Ratio Negative*

Based on the information presented in Table 6 and 7, the diagnostic analysis results indicate that the WHO Cardiovascular Risk Chart (Laboratory-Based) demonstrates a sensitivity of 66.36% and a specificity of 41.75% in the identification of cardiovascular disease events. The positive predictive value (PPV) is recorded at 54.20%, while the negative predictive value (NPV) stands at 54.43%. Further analysis reveals a positive likelihood ratio (LR+) of 1.139 and a negative likelihood ratio (LR-) of 0.806. Overall, the predictive accuracy of the WHO score for cardiovascular disease events within the context of this study was determined to be 54.3%.

Cardiovascular Disease Risk Factors Based on WHO Risk Charts

This study demonstrates that, despite a balanced distribution of gender, significant differences in the risk of cardiovascular disease (CVD) persist. Men are identified as being at a higher risk, as highlighted by Hartopo et al. (2023) and Suratun et al. (2022), who attributed this phenomenon to hormonal and lifestyle factors. In contrast, research conducted by Saraswati and Lina (2020) revealed a greater prevalence of women at high risk, suggesting that hormonal factors, including menopause, contribute to this disparity (Tampubolon et al., 2023). Although age was not found to be statistically significant, it remains a pertinent factor, as a majority of the literature, including studies by Tampubolon et al. (2023), Rochmayanti (2017), and Arifin et al. (2022), indicates that the risk of CVD escalates with age, notably beginning in the fourth decade of life. Additionally, more than half of the respondents were found to have a history of diabetes mellitus (DM), corroborating findings from Idrus (2017) and Rahmawati et al. (2020), which recognize DM as a significant comorbidity associated with CVD. Furthermore, Ma et al. (2022) confirmed that chronic hyperglycemia in individuals with DM accelerates the process of atherosclerosis.

Smoking has been identified as a significant risk factor due to the high prevalence of smokers among patients with cardiovascular disease (CVD), as delineated by Wahidah & Harahap (2021), Johanis et al. (2020), and Pracilia et al. (2018). The detrimental substances present in cigarettes, including nicotine and carbon monoxide, exacerbate vascular function and contribute to the pathogenesis of CVD. A systolic blood pressure of ≥140 mmHg was also frequently observed among respondents, thereby reinforcing the assertions made by Amisi et al. (2018), Johanis et al. (2020), and Haldy & Kurniawidjaja (2024) regarding the role of hypertension as a major risk factor for cardiovascular disease. Additionally, a substantial proportion of respondents exhibited total cholesterol levels of ≥5 mmol/L, indicating a significant prevalence of dyslipidemia. Research conducted by Safitri et al. (2023), Naomi et al. (2021), and Mortensen & Nordestgaard (2022) corroborates the substantial influence of hypercholesterolemia on the formation of atherosclerotic plaques and the occurrence of coronary heart disease events.

A total of 51% of respondents were categorized as having cardiovascular disease, indicating a significant burden of CVD within this population. This finding underscores the urgency of implementing risk prediction tools, such as the WHO Cardiovascular Risk Chart. The predominant medical diagnoses included diabetes mellitus (DM) (26.2%), coronary heart disease (24.8%), and hypertension (20.5%), thereby confirming that metabolic disorders are a major contributor to the incidence of CVD. These results are consistent with the work of Paramita et al. (2022), who identified diabetes as a salient comorbidity that accelerates atherosclerosis and elevates the risk of coronary heart disease and stroke.

The majority of respondents were classified within the moderate risk category (10%–<20%), comprising a proportion of 45.2%. This finding suggests that nearly half of the study population may potentially experience a cardiovascular disease (CVD) event within the next decade. Additionally, the proportion of individuals categorized as high risk (≥20%), which stands at 17.2%, underscores the necessity for intensive interventions in this cohort, particularly through the management of blood pressure, lipids, and blood glucose levels. In contrast, the very low risk group (<10%) was relatively small, accounting for only 10%, which likely reflects individuals with either a low risk profile or a younger age demographic. This observation is consistent with the findings of Ridwanmo et al. (2020) and underscores the significance of CVD risk screening, even in asymptomatic individuals, as moderate risk may progress to high risk if not addressed promptly.

a. Gender

   This study demonstrated a significant association between sex and the incidence of cardiovascular disease (CVD). This finding is consistent with Marleni and Alhabib (2017), who reported that males had a 31.25-fold higher likelihood of developing coronary heart disease. However, contrasting results were reported by Nugroho et al. (2022), who found that females exhibited a higher risk. Similarly, Arsyad et al. (2022) and Arifin et al. (2022) indicated that women have a higher prevalence of various metabolic risk factors. Physiologically, estrogen in premenopausal women exerts a cardioprotective effect (Wahyuni et al., 2022; Jumayanti et al., 2020). However, following menopause, the risk of CVD increases in parallel with declining hormone levels (Aquarista, 2017). Therefore, preventive interventions should take into account sex differences as well as hormonal status (Santoso et al., 2023).

b. Age

   No significant association was found between age and the incidence of CVD in this study, which is in line with the findings of Rahayu et al. (2021). However, other studies, such as Nugroho et al. (2022) and Popa et al. (2020), have identified age as a strong predictor of cardiovascular disease. Aging is known to contribute to decreased arterial elasticity and increased vascular stiffness (Tiksnadi, 2019). The

discrepancy between findings may be attributed to a relatively even age distribution within the sample, the use of preventive treatments among older individuals, and the potential influence of unmeasured confounding factors.

c. Smoking
Smoking was found to be significantly associated with the incidence of cardiovascular disease (CVD). This finding is consistent with the meta-analysis conducted by Hackshaw et al. (2018), which demonstrated that even smoking a single cigarette per day significantly increases the risk of coronary heart disease and stroke. The underlying mechanisms include endothelial damage, increased platelet aggregation, and the harmful effects of chemical substances contained in tobacco, all of which contribute to vascular dysfunction (Bernard et al., 2019; Parmar et al., 2023). Furthermore, exposure to secondhand smoke has also been shown to have detrimental effects (Asfar et al., 2018), thereby reinforcing the urgency of smoking cessation interventions.

d. Diabetes Mellitus
This study did not identify a significant association between diabetes mellitus (DM) and CVD, which is consistent with the findings of Naomi et al. (2021). However, Zakaria et al. (2022) reported a significant relationship between DM and CVD among elderly populations. These discrepancies may be attributed to differences in population characteristics, age distribution, and analytical approaches. From a physiological perspective, DM accelerates atherosclerosis through endothelial damage and oxidative stress (Wahyuni, 2022). However, such effects may not be detectable in heterogeneous populations or in individuals with well-controlled glycemic status.

e. Systolic Blood Pressure (Hypertension)
No significant association was observed between hypertension and CVD in this study, supporting the findings of Kamilla and Salim (2018). In contrast, Zakaria et al. (2022) demonstrated that hypertension significantly increases the risk of CVD, particularly in older populations. This inconsistency may be explained by the influence of antihypertensive treatment, the inherent limitations of a cross-sectional design, or the predominance of other risk factors. Pathophysiologically, hypertension contributes to endothelial damage, activation of the renin–angiotensin–aldosterone system (RAAS), and oxidative stress, all of which promote vascular dysfunction and increase the risk of CVD (Rosendorff et al., 2015).

f. Total Cholesterol
A significant association was found between total cholesterol levels and CVD. However, the direction of the association indicated a higher proportion of CVD cases among individuals with lower cholesterol levels. This finding contradicts classical theory, in which hypercholesterolemia is recognized as a major risk factor for CVD (Zakaria et al., 2022; Wahyuni et al., 2022). Lower cholesterol levels at a younger age are associated with reduced CVD risk, whereas elevated cholesterol levels increase the risk (Kamilla and Salim, 2018). The unexpected findings in this study may be influenced by lipid-lowering therapy, sample selection bias, or acute clinical conditions that can reduce cholesterol levels. Nevertheless, cholesterol management remains a critical component of cardiovascular disease prevention (Santoso et al., 2023).

Accuracy of the WHO Cardiovascular Risk Chart (Laboratory-Based)

The receiver operating characteristic (ROC) curve analysis in this study demonstrated that the Area Under the Curve (AUC) of the WHO Cardiovascular Risk Chart (Laboratory-Based) was low and not statistically significant. With an AUC value of 0.564 ($p = 0.107$), the predictive accuracy for cardiovascular disease (CVD) risk can be considered weak and only marginally better than random chance. This finding is consistent with Çorbacıoğlu and Aksel (2023), who stated that an AUC between 0.5 and <0.6 indicates poor discriminatory ability. The receiver operating characteristic (ROC) curve analysis in this study demonstrated that the Area Under the Curve (AUC) of the WHO Cardiovascular Risk Chart (Laboratory-Based) was low and not statistically significant. With an AUC value of 0.564 ($p = 0.107$), the predictive accuracy for cardiovascular disease (CVD) risk can be considered weak and only marginally better than random chance. This finding is consistent with Çorbacıoğlu and Aksel (2023), who stated that an AUC between 0.5 and <0.6 indicates poor discriminatory ability.

The study by Kasim et al. (2023) provides additional insight into predictive performance at different cut-off points. At a cut-off of 10%–<20%, sensitivity increased to 51.8%, albeit with low specificity (24.1%). Conversely, at a higher cut-off of 20%–<30%, sensitivity declined to 19.0%, while specificity markedly increased to 93.5%. The low specificity at lower cut-off thresholds suggests a substantial risk of false-positive results, which may lead to unnecessary medical interventions and impose psychological burdens on patients.

In comparative model analyses, Birhanu et al. (2024), in a population-based study in India, found that the Australian Risk Score (ARS) outperformed the WHO Risk Score (WHO-RS), demonstrating a sensitivity of 44.1% and specificity of 79.9% over a 5-year follow-up period. In contrast, the WHO-RS showed a markedly low sensitivity of 2.0%, despite achieving very high specificity (99.0%). Similarly, the Globorisk model, in both laboratory-based and non-laboratory-based versions, demonstrated superior predictive accuracy compared to the WHO-RS.

Overall, the WHO risk charts appear to be more effective in identifying individuals at low risk, yet lack sufficient sensitivity in detecting those at high risk. The limited predictive accuracy observed in this study may be attributed to the lack of region-specific data used in the development of the WHO risk charts, resulting in suboptimal representation of local population characteristics, including outpatient populations at Dr. Sitanala General Hospital.

Therefore, these findings underscore the need for recalibration of the WHO risk charts or the development of more population-specific predictive models that are tailored to local risk profiles. Model adaptation based on national or institution-specific data is expected to improve sensitivity, specificity, and the overall accuracy of cardiovascular risk prediction.

CONCLUSION

This study demonstrates that the majority of outpatients at Dr. Sitanala General Hospital exhibit cardiovascular disease (CVD) risk factors, including age <60 years, male sex, elevated cholesterol levels, and diabetes mellitus. Although most patients were classified within the moderate-risk category based on the WHO Cardiovascular Risk Chart (Laboratory-Based), this tool was unable to consistently discriminate between patients with and without clinically diagnosed CVD. Significant associations were identified between CVD incidence and sex, smoking status, and total cholesterol levels. However, no statistically significant associations were observed between age, systolic blood pressure, and diabetes status and the occurrence of CVD. Furthermore, the WHO Risk Chart demonstrated low predictive accuracy (AUC 0.564; $p = 0.107$), with suboptimal sensitivity and specificity, indicating that it is not sufficiently reliable to be used as a standalone screening tool in this population.

This study suggests that the use of the WHO Cardiovascular Risk Chart (Laboratory-Based) should be applied with caution in the outpatient population at Dr. Sitanala General Hospital and should be complemented with comprehensive clinical assessments, such as electrocardiography (ECG) and echocardiography, to improve the accuracy of cardiovascular disease detection. Further research is recommended using prospective study designs, larger sample sizes, and more diverse populations to evaluate the external validity of the WHO Risk Charts and to compare their performance with other predictive tools. Additionally, hospitals and policymakers are encouraged to adapt cardiovascular risk prediction tools to better reflect local population characteristics, as well as to enhance the quality of medical record documentation and digitalization to support more robust data-driven decision-making and research.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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