International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Assessment of Biochemical Risk Factors of Coronary Artery Disease in North and South Indian Population

Shashwat Singh[1], Suchit Swaroop[2]

[1]Research Scholar, Department of Zoology, University of Lucknow, 226007, India
[2]Associate Professor, Department of Zoology, University of Lucknow, 226007, India

Abstract
Coronary artery disease (CAD) in India is closely linked to elevated body mass index (BMI), dyslipidemia, and metabolic risk factors. Studies from Northern India, including Himachal Pradesh, Uttar Pradesh, and Jammu & Kashmir, show high obesity prevalence, especially in rural and tribal populations, with low HDL and borderline triglyceride levels. Advanced lipid markers like oxidized LDL (ox-LDL) and small dense LDL (sdLDL) are more effective in predicting premature CAD than traditional markers. In Southern India, particularly in Kerala and Andhra Pradesh, similar trends of elevated BMI, dyslipidemia, and gender-specific risks are observed, with associations between abdominal obesity, high cholesterol, and low HDL. Additionally, epicardial adipose tissue (EAT) thickness and lipoprotein-associated phospholipase A2 (Lp-PLA2) activity are identified as independent CAD predictors. Both regions share common risk factors, exacerbated by urbanization and changing lifestyles, highlighting the need for targeted public health interventions to manage CAD risk factors effectively.

Keywords: Coronary Artery Disease, Biochemical studies, North India, South India.

Introduction

Coronary artery disease (CAD) is a growing health concern in India, influenced by a variety of risk factors across different age groups [1]. Common contributors include hypertension, diabetes mellitus and dyslipidaemia, with these conditions being interrelated in many patients [2][3]. While population-level surveys using sociodemographic and non-laboratory-based data provide insight into the burden of cardiovascular disease, laboratory-based assessments, such as blood pressure, serum cholesterol, and blood glucose levels, offer more accurate risk evaluation. [2]. Dyslipidaemia, a classical risk factor for CAD, significantly drives the rise of non-communicable diseases in India [4]. Studies highlight the genetic predisposition of Indians to CAD, often exacerbated by environmental factors. Indians are more prone to higher levels of atherogenic lipoprotein (a) and lower levels of anti-atherogenic HDL cholesterol, distinguishing them from other ethnic groups. These abnormalities, coupled with advanced lipid parameters like oxidized LDL and small dense LDL, underline the complexity of CAD in the Indian population, where conventional lipid metrics alone cannot fully explain premature CAD occurrences [5]. Additionally, conditions like type 2 diabetes mellitus (T2DM) and hypertension (HTN) independently contribute to adverse cardiac effects, such as increased arterial stiffness and impaired myocardial function [6]. Indian patients exhibit unique patterns of dyslipidaemia, characterized by low HDL and high

triglycerides—termed atherogenic dyslipidaemia—which pose significant therapeutic challenges [7]. This contrasts with Western populations where high cholesterol predominates as a major risk factor. Novel biochemical markers such as high-sensitivity C-reactive protein (hs-CRP) and homocysteine (Hcy) further emphasize the multifactorial nature of CAD risk. These insights underscore the importance of targeted interventions focusing on both traditional and novel risk factors to mitigate the growing burden of CAD in India [8].

Aim of the study

The study aimed to examine the prevalence of various biochemical risk factors associated with coronary artery disease (CAD) in North and South Indian populations.

Study Design

An in-depth literature review was conducted to thoroughly to assess key risk factors of coronary artery disease (CAD) including Body Mass Index (BMI), Total Cholesterol (TC), Triglycerides (TGs) Low-Density Lipoprotein (LDL) levels and High-Density Lipoprotein (HDL) levels.

Results and Discussion

The study focused on two regions of India: The Northern region, comprising Chandigarh, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Uttar Pradesh and Uttarakhand, and the Southern region, encompassing Andhra Pradesh, Karnataka, Kerala, Pondicherry, Tamil Nadu and Telangana.

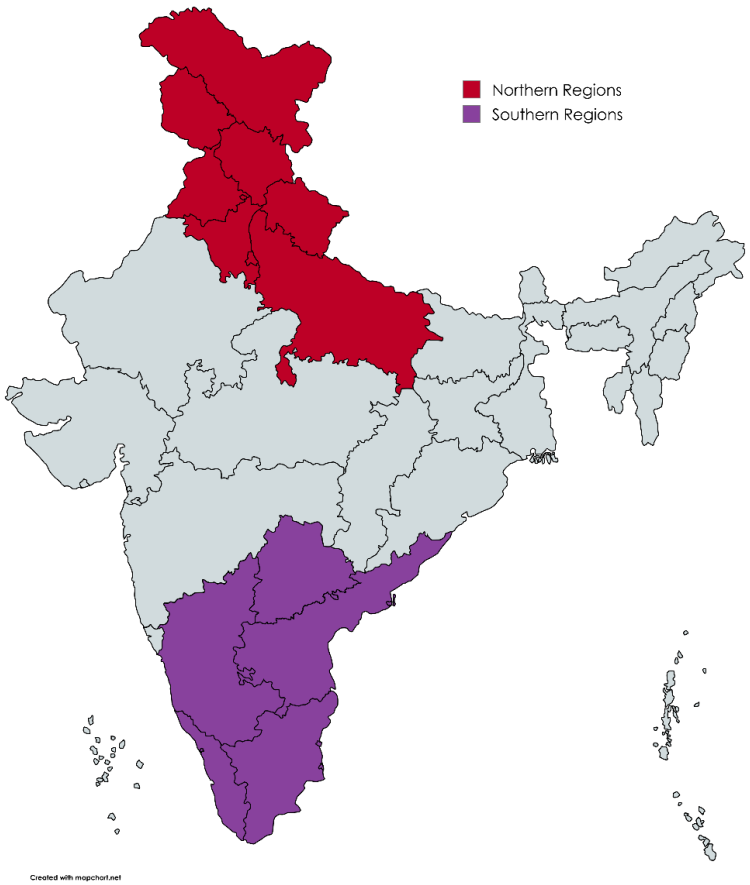

Figure 1. Map showing regions of North and South India included in the study

Table 1: Analysis of Biochemical Risk factors in different regions of Northern India

Author	Study Year	Region	Population Size	Mean-BMI (Kg/m^2)	Mean-TC (mg/dl)	Mean-TGs (mg/dl)	Mean-LDL-levels (mg/dl)	Mean-HDL levels (mg/dl)
Bhardwaj et al. 2013 [9]	2013	Himanchal Pradesh	900 (450 Rural & 450 Tribal)	21.0 (Rural) 21.5 (Tribal)	165.60 (Rural) 171.0 (Tribal)	109.10 (Rural) 96.40 (Tribal)	91.80 (Rural) 95.90 (Tribal)	40.50 (Rural) 41.60 (Tribal)
Bansal et al. 2015 [5]	2015	Delhi	60 (30 Cases & 30 Controls)	_	163.57 (Case) 193.53 (Control)	163.57 (Case) 183.10 (Control)	88.05 (Case) 115.67 (Control)	42.67 (Case) 38.10 (Control)
Singh et al. 2017 [10]	2017	Uttar Pradesh	500 (250 T2DM CAD & 250 Controls)	23-24.9 (T2DM CAD) 18-22.9 (Controls)	258.53 (T2DM CAD) 180.00 (Controls)	186.00 (T2DM CAD) 110.06 (Controls)	201.00 (T2DM CAD) 117.24 (Controls)	29.00 (T2DM CAD) 53.00 (Controls)
Sinha et al. 2018 [12]	2018	Uttar Pradesh	350	213 (Normal-BMI) 137 (High-BMI)	267 (Normal-TC) 83 (High-TC)	252 (Normal-TGs) 98 (High-TGs)	248 (Normal-LDL) 102 (High-LDL)	106 (Below Normal-HDL) 244 (Normal-HDL)
Jammu et al. 2018 [13]	2018	Jammu and Kashmir	460 (220 Cases & 240 Controls)	24.34 (Case) 22.99 (Controls)	212.47 (Case) 171.78 (Controls)	240.24 (Case) 143.65 (Controls)	129.48 (Case) 102.34 (Controls)	41.23 (Case) 44.89 (Controls)
Gautam et al. 2018 [14]	2018	Uttar Pradesh	120 Cases	_	268.2	214.50	108.40	43.20
Kaur et al. 2019 [17]	2019	Chandigarh	1000 (500 Cases & 500 Controls)	Normal-BMI: 296 Cases, 270	144.95 (Case) 275.76	145.37 (Case) 198.23	76.54 (Case) 135.65	88.06 (Case) 52.35

				Controls) High BMI: 204 Cases, 230 Controls)	(Controls)	(Controls)	(Controls)	(Controls)
Chaudhary et al. 2024 [2]	2019	Haryana	4276 (2129 Rural & 2147 Urban)	24.2 (Rural) 26.5 (Urban)	186.4 (Rural) 183.5 (Urban)	_	116.9 (Rural) 115.2 (Urban)	_
Golia et al. 2020 [15]	2020	Uttar Pradesh	400 (300 Cases & 100 Controls)	_	161.20 (Case) 148.30 (Controls)	152.36 (Case) 111.15 (Controls)	94.94 (Case) 76.90 (Controls)	46.01 (Case) 60.75 (Controls)
Nehra et al. 2020 [11]	2020	Uttar Pradesh	100 (50 Non-Smokers, 28 Smokers without CAD and 22 Smokers with CAD)	_	191.40 (Non-Smokers) 200.60 (Smokers without CAD) 234.61 (Smokers with CAD)	121.19 (Non-Smokers) 143.30 (Smokers without CAD) 220.37 (Smokers with CAD)	115.95 (Non-Smokers) 131.94 (Smokers without CAD) 162.08 (Smokers with CAD)	51.26 (Non-Smokers) 40.90 (Smokers without CAD) 26.26 (Smokers with CAD)
Bunker et al. 2022 [16]	2022	Uttar Pradesh	200 Patients (30 Premature CAD, 170 CAD)	27.1 (Premature CAD) 26.9 (CAD)	195 (Premature CAD) 196 (CAD)	159 (Premature CAD) 155 (CAD)	_	38 (Premature CAD) 40 (CAD)

Biochemical findings in North India-

The reviewed studies collectively highlight the complex relationship between body mass index (BMI), lipid profiles, and coronary artery disease (CAD) risk factors in the Indian population. Research conducted in Himachal Pradesh reported a high prevalence of obesity (BMI 27.5–30 kg/m²) and borderline triglyceride levels among tribal and rural populations, with low HDL levels (<40 mg/dL) observed in approximately half of the subjects [9]. Advanced lipid parameters, such as oxidized LDL (ox-LDL) and small dense LDL (sdLDL), were identified as more accurate predictors of premature CAD than

conventional lipid markers [5]. Investigations from 2017 and 2020 in Uttar Pradesh revealed adverse lipid profiles in CAD patients, characterized by elevated triglycerides, LDL, and VLDL, alongside reduced HDL, with exacerbating factors such as type 2 diabetes mellitus and smoking, respectively [10], [11]. Further, research from Uttar Pradesh [12] and Jammu & Kashmir [13] linked urban lifestyles, elevated BMI, and dysregulated lipid levels—including significantly higher total cholesterol (TC) and LDL—to an increased risk of cardiovascular diseases. Hyperlipidemia was identified as a prevalent risk factor, with an average TC of 268.2 mg/dL and HDL of 43.2 mg/dL [14]. A 2020 investigation from Uttar Pradesh also highlighted gender differences in obesity metrics among CAD patients [15]. Additionally, a 2022 study associated premature CAD with low HDL levels, along with other risk factors, including high familial risk, smoking, and tobacco use [16].

Author	**Study Year**	**Region**	**Population Size**	**Mean-BMI (Kg/m^2)**	**Mean-TC (mg/dl)**	**Mean-TGs (mg/dl)**	**Mean-LDL-levels (mg/dl)**	**Mean-HDL-levels (mg/dl)**
Krishnan et al. 2016 [18]	2012	Kerala	5167	Normal-BMI (<25): 796/5167 High-BMI (>25): 1448/5167	Normal-TC (<190mg%): 4272/5167 High-TC (>190mg%): 849/5167	_	Normal-LDL (>100mg%): 4271/5167 Low-LDL (<100mg%): 849/5167	_
Oommen et al. 2016 [19]	2012	Tamil Nadu	2397 (Urban) 3799 (Rural)	Normal-BMI (<25): 221/3140 High-BMI (>25): 169/2062	Normal-TC (<190mg%): 198/3015 High-TC (>190mg%): 177/1867	Normal-TGs (<150mg%): 110/1308 High-TGs (>150mg/%): 267/3583	Normal-LDL (>100mg%): 69/1089 Low-LDL (<100mg%): 306/3793	_
Jyothi et al. 2018 [20]	2014-2015	Telangana	440 (26 Cases & 414 Controls)	24.71 (Case) 24.74 (Controls)	179.64 (Case) 171.78 (Controls)	146.64 (Case) 171.78 (Controls)	95.67 (Case) 102.03 (Controls)	43.19 (Case) 43.47 (Controls)
Verma et al. 2019 [21]	2015	Pondicherry	500 (250 Cases &	25.1 (Case) 24.6	162 (Case)	213.7 (Case)	141.3 (Case)	39.6 (Case) 42.2

			250 Controls)	(Controls)	115 (Controls)	211.3 (Controls)	123.5 (Controls)	(Controls)
Chand et al. 2016 [24]	2015	Andhra Pradesh	1024 (508 Cases & 516 Controls)	26.02 (Case) 26.9 (Controls)	153.6 (Case) 190.6 (Controls)	148.4 (Case) 161.0 (Controls)	84.7 (Case) 113.6 (Controls)	41.3 (Case) 47.7 (Controls)
Sairam et al. 2017 [22]	2017	Three regions of South India	200 (97 Cases & 93 Controls)	22.6 (Case) 23.3 (Controls)	188.5 (Case) 189 (Controls)	141 (Case) 123 (Controls)	117 (Case) 123 (Controls)	38 (Case) 43 (Controls)
Varadhan et al. 2022 [25]	2021	Pondicherry	160 (100 Cases & 60 Controls)	28.40 (Case) 24.07 (Controls)	225.49 (Case) 196.92 (Controls)	173.84 (Case) 125.25 (Controls)	148.62 (Case) 128.68 (Controls)	44.29 (Case) 52.88 (Controls)
Chaudhary et al. 2024 [2]	2019	Andhra Pradesh	4172 (2200 Rural & 1972 Urban)	22.0 (Rural) 26.1 (Urban)	178.7 (Rural) 185.3 (Urban)	_	114.9 (Rural) 118.8 (Urban)	_
Issac et al. 2023 [23]	2022	Kerala	102	Normal-BMI (<25): 37/102 High-BMI (>25): 65/102	Normal-TC (<200mg %): 62/102 High-TC (>200mg %): 40/102	Normal-TGs (<150mg %): 73/102 High-TGs (>150mg %): 29/102	Normal-LDL (>100mg %): 33/102 Low-LDL (<100mg %): 69/102	Normal-HDL (>40mg %): 87/102 Low-HDL (<40mg %): 15/102

Table 2: Analysis of Biochemical Risk factors in different regions of Southern India

Biochemical findings in South India-

The prevalence and risk factors associated with coronary artery disease (CAD) in India have been extensively investigated, with research highlighting significant correlations with body mass index (BMI), lipid profiles, and metabolic parameters. In 2016, research in Kerala reported a high prevalence of overweight or obesity (59%) and abdominal obesity (57%) among CAD patients, alongside elevated total cholesterol levels (52%) and low high-density lipoprotein (HDL) cholesterol (39%) [18]. Another 2016 report documented a substantial increase in CAD prevalence, particularly among urban women, attributing this rise to escalating metabolic and lifestyle-related risk factors [19].

In 2018, research found significantly higher triglyceride levels among CAD patients compared to non-CAD individuals, though LDL and other lipid parameters were comparable [20]. A 2019 investigation in Pondicherry identified a strong positive correlation between epicardial adipose tissue (EAT) thickness and low-density lipoprotein cholesterol (LDL-C), establishing EAT as an independent predictor of CAD [21]. Additionally, lipoprotein-associated phospholipase A2 (Lp-PLA2) activity was shown to positively correlate with total cholesterol, LDL-C, and non-HDL cholesterol, while negatively correlating with HDL-C [22].

The prevalence of risk factors such as hyperlipidaemia, hypertension, and diabetes across both urban and rural populations in northern and southern India was documented in 2019 research from Andhra Pradesh [2]. Furthermore, a 2024 report highlighted alarmingly high rates of obesity (63.7%) and elevated total cholesterol levels (39.2%) among women in Kerala, underscoring the urgent need for targeted lifestyle interventions [23].

Conclusion

The studies examining coronary artery disease (CAD) risk factors from both Northern and Southern India underscore the widespread influence of elevated body mass index (BMI) and dyslipidemia, with notable regional similarities and differences. In Northern India, research conducted in states such as Himachal Pradesh, Uttar Pradesh, and Jammu & Kashmir highlights a high prevalence of obesity, particularly among rural and tribal populations, with low high-density lipoprotein (HDL) levels and borderline triglyceride levels commonly observed [9], [10], [11]. Elevated total cholesterol (TC) and LDL levels, compounded by type 2 diabetes mellitus and smoking, are consistently identified as significant risk factors for CAD [12], [13]. Moreover, advanced lipid parameters, such as oxidized LDL (ox-LDL) and small dense LDL (sdLDL), have been identified as more accurate predictors of premature CAD than conventional lipid markers [5].

In contrast, Southern India, particularly in Kerala and Andhra Pradesh, shows a similarly high prevalence of overweight and obesity among CAD patients, with significant correlations to elevated total cholesterol and reduced HDL cholesterol levels [18], [19]. Research from Kerala reports alarmingly high rates of abdominal obesity and elevated cholesterol, particularly among women, suggesting distinct gender-specific cardiovascular risks [23]. Additionally, studies from Pondicherry and Andhra Pradesh emphasize the role of metabolic parameters, such as epicardial adipose tissue (EAT) thickness and lipoprotein-associated phospholipase A2 (Lp-PLA2) activity, as independent predictors of CAD [21], [22]. The impact of urbanization, along with rising rates of hyperlipidaemia, hypertension, and diabetes, is consistent across both urban and rural populations in these regions [2].

While both Northern and Southern India exhibit a strong correlation between elevated BMI, dyslipidemia, and CAD risk, the Southern studies place particular emphasis on specific lipid markers and highlight the growing gender differences in obesity metrics. Collectively, these findings underscore the need for targeted public health interventions to address the escalating burden of CAD in India, particularly in the context of urbanization, lifestyle changes, and the increasing prevalence of metabolic risk factors across both regions.

References

1. Jayachandra, S., Agnihotram, G., Rao, P. R., & Murthy, V. C. (2014). Risk-factor profile for coronary artery disease among young and elderly patients in Andhra Pradesh. *Heart India*, *2*(1), 11-14.

2. Chaudhary, R. S., Venkateshmurthy, N. S., Dubey, M., Jarhyan, P., Prabhakaran, D., & Mohan, S. (2024). Regional and socio-demographic variation in laboratory-based predictions of 10-year cardiovascular disease risk among adults in north and south India. *Indian Heart Journal*, *76*(4), 271-279.
3. Baruah, S., Chaliha, M. S., Borah, P. K., Rajkakoti, R., Borua, P. K., Kalita, H. C., & Mahanta, J. (2015). Risk factors associated with myocardial infarction in a north east Indian study. *Int J Health Sci Res*, *5*, 41-52.
4. Banerjee, R., Bhattacherjee, S., Ray, K., Roy, J. K., Datta, S., & Banerjee, I. (2014). Dyslipidemia and its Relationship with Cardiovascular Risk Factors in a Selected Population of Siliguri City, West Bengal, India. *Asian Journal of Medical Sciences*, *5*(1), 1-8.
5. Bansal, S. K., Agarwal, S., & Daga, M. K. (2015). Conventional and advanced lipid parameters in premature coronary artery disease patients in India. *Journal of Clinical and Diagnostic Research: JCDR*, *9*(11), BC07.
6. Kumar, S., & Dessai, B. P. S. (2023). Epidemiological profile among young patients (≤ 45 years) suffering from acute myocardial infarction in a tertiary care center in Goa. *Indian Journal of Health Sciences and Biomedical Research kleu*, *16*(1), 125-129.
7. Mahalle, N., Garg, M. K., Naik, S. S., & Kulkarni, M. V. (2014). Study of pattern of dyslipidemia and its correlation with cardiovascular risk factors in patients with proven coronary artery disease. *Indian journal of endocrinology and metabolism*, *18*(1), 48-55.
8. Sahu, A., Gupta, T., Kavishwar, A., & Singh, R. K. (2015). Cardiovascular diseases risk prediction by homocysteine in comparison to other markers: a study from Madhya Pradesh. *J Assoc Physicians India*, *63*(10), 37-40.
9. Bhardwaj, A. K., Kumar, D., Raina, S. K., Bansal, P., Bhushan, S., & Chander, V. (2013). Community based assessment of biochemical risk factors for cardiovascular diseases in rural and tribal area of Himalayan Region, India. *Biochemistry Research International*, *2013*(1), 696845.
10. Singh, M., Anwer, E., & Kumar, V. (2017). Assessment of biochemical parameters in the patients of coronary artery disease with type 2 diabetes mellitus. *Int J Pharm Sci Res*, *8*(3), 1420-26.
11. Nehra, R., Soobia, K. A., Nasir, A., Nehra, M., & Aggarwal, N. (2020). Lipid peroxidation and antioxidant status in cigarette smokers ischemic heart disease (IHD) patients. *International Journal of Advanced Biochemistry Research*, *4*(2), 17-19.
12. Sinha, V., & Kachhawa, P. (2019). Biochemical assessment of risk factors in coronary artery disease patients: An observational study in suburban hospital of Hapur, Uttar Pradesh. *Asian Journal of Medical Sciences*, *10*(2), 35-39.
13. Jammu, J. (2018). A pilot study on recognition and prevalence of risk factors for cardiovascular diseases in north Indian populace of Jammu and Kashmir. *J Hum Ecol*, *62*(1-3), 47-57.
14. Gautam, D. K., Kanojia, M. L., Kumar, V., & Mishra, P. K. (2019). Assessment of Risk Factors of Coronary Artery Disease in Subjects Attending a Tertiary Care Facility in North India-A Clinical Study. *Journal of Advanced Medical and Dental Sciences Research*, *7*(3).
15. Golia, N., Krishan, K., & Kashyap, J. R. (2020). Assessment of obesity by using various anthropometric measurements among patients with coronary heart disease residing in north India. *Cureus*, *12*(5).

16. Bunker, G. K., Patidar, M., Atal, D., & Meena, R. L. (2022). Evaluation of Risk Factors of Premature Coronary Artery Disease in Patients From North India: A Rising Epidemic. *Indian Journal of Clinical Cardiology*, *3*(4), 183-187.
17. Kaur, N., Singh, J., & Reddy, S. (2019). The LOX1 gene polymorphisms and coronary artery disease in North Indian population. *Archives of Clinical and Biomedical Research*, *3*(2), 21-35.
18. Krishnan, M. N., Zachariah, G., Venugopal, K., Mohanan, P. P., Harikrishnan, S., Sanjay, G., ... & Thankappan, K. R. (2016). Prevalence of coronary artery disease and its risk factors in Kerala, South India: a community-based cross-sectional study. *BMC cardiovascular disorders*, *16*, 1-12.
19. Oommen, A. M., Abraham, V. J., George, K., & Jose, V. J. (2016). Prevalence of coronary heart disease in rural and urban Vellore: a repeat cross-sectional survey. *Indian heart journal*, *68*(4), 473-479.
20. Jyothi, L., Nuthalapati, R. K., & Peddy, S. R. (2018). Prevalence of coronary artery disease and its relationship with various cardiovascular risk factors: Analysis of south Indian patients. *Journal of Indian College of Cardiology*, *8*(3), 138-142.
21. Verma, B., Katyal, D., Patel, A., Singh, V. R., & Kumar, S. (2019). Relation of systolic and diastolic epicardial adipose tissue thickness with presence and severity of coronary artery disease (The EAT CAD study). *Journal of family medicine and primary care*, *8*(4), 1470-1475.
22. Sairam, S. G., Sola, S., Barooah, A., Javvaji, S. K., Jaipuria, J., Venkateshan, V., ... & Sanjeevi, C. B. (2017). The role of Lp-PLA2 and biochemistry parameters as potential biomarkers of coronary artery disease in Asian South-Indians: a case-control study. *Cardiovascular diagnosis and therapy*, *7*(6), 589.
23. Issac, R. (2023). Prevalence of Risk Factors of Coronary Artery Disease among Women. *Indian Journal of Nursing Sciences*, 58-63.
24. Pranav Chand, R., Kumar, A. S., Anuj, K., Vishnupriya, S., & Mohan Reddy, B. (2016). Distinct patterns of association of variants at 11q23. 3 chromosomal region with coronary artery disease and dyslipidemia in the population of Andhra Pradesh, India. *PLoS One*, *11*(6), e0153720.
25. Varadhan, S., Venkatachalam, R., Perumal, S. M., & Ayyamkulamkara, S. S. (2022). Evaluation of oxidative stress parameters and antioxidant status in coronary artery disease patients. *Archives of Razi Institute*, *77*(2), 853.