CARDIOVASCULAR RISK MODULATION BY LIFESTYLE MODIFICATION AS PREDICTED BY NOVEL "ARTIFICIAL INTELLIGENCE BASED" CARDIOVASCULAR DISEASE (AICVD) RISK SCORE

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ABSTRACT

Background: The pandemic of cardiovascular diseases (CVD) contribute maximally to the global mortality[1], hence the focus on primary prevention by risk factor modulation is of vital importance. AICVD Cardiac Risk Score[2] is a novel artificial intelligence-based risk prediction score system that provides the individual's future risk of CV events. We planned to study the impact of lifestyle modification on the CV risk status as measured by AICVD risk score. **Methods:** A prospective interventional study was conducted over a time period of one year from January- December 2021. Cohort of 312 patients with age group 40-60 years having at least one of the four traditional cardiovascular risk factors for CAD i.e. DM, Hypertension, Smoking and Dyslipidemia were included in study, The primary outcome measure was to compare the change in AICVD risk score and category after 6 months of intense lifestyle modification. Secondary outcomes were changes in blood pressure, body-mass index, serum cholesterol, blood glucose, smoking cessation, physical activity and stress level. **Result:** In a cohort of 312 patients, Baseline CVD risk was calculated by using "AICVD risk calculator" and measures of Intense lifestyle modifications were advised to all patients and their CVD risk was again calculated at the end of 6 months and change in AICVD risk score and category was compared from baseline. The result showed significant **27.72% change in mean value in AICVD risk score after lifestyle modification (p-valve <0.001)** while optimal risk score did not changed significantly (p value = 0.317). After life style modification, 93.1%% moderate risk category patients had noted significant drop in their CVD risk category from moderate to minimal risk **(p-value=<0.001)** and 86.02% high-risk patients had noted drop in their CVD risk category from high to either moderate (84.94%) or minimal risk (1.07%) category **(p-value=<0.001)**. **Conclusions**: By applying intense lifestyle modification, majority of moderate and high-risk category patients who had more than 1 risk factors of CAD at baseline showed very significant change in their AICVD risk score and category at the end of 6 months but the obese or overweight patients with other risk factor do not show such significant change in their CVD risk. This signifies that obesity is the most important modifiable risk factor of CAD.

KEYWORDS: CVD risk factors, AICVD risk calculator, Intense lifestyle modification, Change in AICVD risk score and category.

INTRODUCTION

Cardiovascular diseases (CVD) are one of the most prevalent diseases in India causing nearly 30% of total deaths. CVD account for over 60% of morbidity and mortality in India (WHO Report - Sept 2017).[1] There is a widespread epidemic of CVD in the low and middle income countries due to increase in obesity, diabetes and hypertension rate, hence the focus on risk factor prevention is of vital importance. Ever since the concept of preventive cardiology has come into vogue, several risk identification models have come up which combine several risk factors to create a risk prediction score for

occurrence of cardiovascular (CV) event, for example, the Framingham[3], ACC/AHA ASCVD[4] and QRISK[5] models etc.

AICVD Cardiac Risk Score.[2] is a novel artificial intelligence based risk prediction score system that provides the individual's risk of having Coronary Artery Disease related events in the next 10 Years. The risk score is developed by Apollo Hospitals with further validation from National and International institutions. The methodology helps to stratify the patients risk with an accuracy above 90%. List of Risk Factors included in AICVD risk calculator– Personal/VS – Age | Gender | Height | Weight | BMI, Heart Related Attributes - Heart Rate | Systolic BP | Diastolic BP | Respiratory Rate, Cardiac Symptoms | Heart Rhythm | New! – Psychological Stress, Life Style Attributes - Diet | Alcohol | Smoking | Tobacco Use, Physical Activity Medical History-|Dyslipidaemia*|Diabetes mellitus*| Medication for Hypertension* (*Diagnosis or Medication),. Previous CAD, Family History of CAD

Periodic risk assessment offers the opportunity to identify CVD risk factors and offer guidance on the appropriate management of specific risk factors (eg, dietary modifications for hypertension or dyslipidemia) and overall CVD risk (eg, maintaining a healthy diet, regular exercise etc.). On recognizing the high-risk subset of population, timely amendments on improving lifestyle, dietary habits or necessary drug intervention, can be undertaken. It would be beneficial for both patients and physicians to decide on modalities of treatment, prevention, lifestyle modification, overall predicting the outcome of cardiovascular conditions and risk for further events.

Definition: As used in AICVD risk calculator, parameter defined and categorized as hypertension.[6] diabetes mellitus.[7] dyslipidemia[8] smoking[9] body mass index.[10] alcohol intake.[11] physical activity.[12] psychological stress.[13] and measures of lifestyle modification were advised as per 2013 ACC/AHA guideline of lifestyle modification.[14]

MATERIALS AND METHODS
This prospective interventional study was conducted at tertiary care center of North India over a time span of one year (January- December 2021). The ethical committee of this institution has approved the study protocol. Sample size was calculated on the basis of patient enrolment data of year 2020. Cohort of 312 with

age group 40-60 years having at least one of the four traditional cardiovascular risk factors for CAD i.e. DM, Hypertension, Smoking and Dyslipidemia were included in study, and patients with history of angiographically proven CAD, any previous ACS/PCI/CABG or Cardiomyopathy were excluded. The basic objective of this study was to evaluate the impact of intense life style modification on changes in cardiovascular risk status. The primary outcome was to compare the change in AICVD risk score and category after 6 months of intense lifestyle modification. Secondary outcomes were control of hypertension, diabetes, dyslipidemia, change in BMI, smoking cessation, physical activity and psychological stress. AICVD risk of every patient was calculated at baseline by using "AICVD risk calculator" and measures of Intense lifestyle modifications were advised for 6 months and this will be followed by re-evaluation of the study cohort after a period of six months. In this initial and later evaluation, AICVD risk score will be compared and checked for improvement

AICVD Risk Calculator
Apollo Hospitals and Microsoft developed the Cardiovascular Risk Score in Indian population by using AI and Machine Learning (ML). Total 31,599 participants aged between 18 to 91 were enrolled between year 2010 to 2017 in six Apollo Hospitals in India. Objective is to develop an Artificial Intelligence based Risk Score (AICVD) to predict CVD Event in next 10 years and compare the model with Framingham Heart Risk Score (FHRS) and QRisk3. Deep Leaning Hazard Model was built on 21 risk factors to predict event occurrence (classification) and time to event (hazard model) using multi-layered neural network. Further, the model was validated with independent retrospective cohorts of participants from India and the Netherlands. AICVD model uses clinical & lifestyle features to assess Cardiovascular Disease Risk. The study concluded that the novel AI based CVD risk score significantly more accurate than the existing models for prediction of CVD risk in the Indian population. Sensitivity and Specificity of the AICVD (61.31% & 90.04%) is higher than FHRS (37.63% & 82.70%) and QRisk3 (31.03% & 76.08%) respectively. The generated risk scores on clinical parameters were categorized into high risk, moderate risk and low risk categories based on the risks adjusted for age and gender.

<1 (of Optimal Score) - Minimal Risk
1 - 1.5 (of Optimal Score) - Moderate Risk
> 1.5 (of Optimal Score) - High Risk

AICVD RISK SCORE

PATIENT DETAILS

👤 XYZ

🧍 51   ♂ **Male**   ♀ Female

✳ 00000000

📍 Lucknow

@ xyz123@gmail.com

📞 9999999999

PATIENT INFORMATION SHEET AND INFORMED CONSENT ↗

☑ Patient has confirmed that he/she has read and understood the information sheet f the above Risk Scores and have had the opportunity to ask questions

☑ Patient has agreed to take part in the above NCD Risk Scores in Apollo Hospitals.

Next

AICVD RISK SCORE

PHYSICAL ATTRIBUTES

Height /cm	Weight /kg	BMI
�🇮 170	🖳 85	🖩 29.41

HEART HEALTH ATTRIBUTES

Heart Rate /min Range (40 - 150)	Systolic BP /min Range (90 - 200)
❤ 74	🩸 176

Diastolic BP /min Range (50 - 140)	Respiration Rate /min Range (10 - 40)
🩸 110	🏃 16

Pulse Rhythm

〽 Regularly Regular

Chest Pain / Shortness of Breath/ Other Symptoms ⓘ   ◉ Yes   ○ No

PSYCHOLOGICAL ATTRIBUTES

Psychological Stress

◔ AnxietySyndromes

LIFESTYLE

Diet ⓘ	○ Non-Veg	◉ Veg	○ Mix
Alcohol ⓘ	○ Current	○ Past	◉ No
Smoking ⓘ	○ Current	○ Past	◉ No
Tobacco ⓘ	◉ Yes	○ No	

Physical Activity ⓘ

🏃 Moderate

MEDICAL HISTORY

Diabetes Mellitus ⓘ

📠 Not controlled with medication

Medication For Hypertension ⓘ	◉ Yes	○ No
Dyslipidaemia ⓘ	◉ Yes	○ No
History Of Heart Disease ⓘ	○ Yes	◉ No
Family History Of Heart Disease ⓘ	◉ Yes	○ No

AICVD RISK SCORE REPORT

Name:	XYZ	Age:	51	Location:	Lucknow
UHID:	00000000	Gender:	Male	Date Of Report:	11-3-2022

Informed Consent Obtained

Physical Attributes

Height (cm) : 170
Weight (kg) : 85
BMI : 29.41
Psychological Stress : Anxiety Syndromes

Heart Health Attributes

Heart Rate : 74
Systolic BP : 176
Diastolic BP : 110
Respiration Rate : 16
Pulse Rhythm : Regularly Regular
Chest Pain / Shortness of Breath/ Other Symptoms : Yes

Life Style

Diet : Veg
Alcohol : No
Smoking : No
Tobacco : Yes
Physical Activity : Moderate

Medical History

Diabetes Mellitus : Not controlled with medication
Medication For Hypertension : Yes
Dyslipidaemia : Yes
History Of Heart Disease : No
Family History Of Heart Disease : Yes

Patient Cardiac Risk Score

RISK STATUS	PATIENT SCORE	OPTIMAL SCORE
High Risk	16	7

Note: The risk category is determined through the ratio between patient score and optimal score at multiple decimal points. The Outputs are shown in whole numbers.

Top Modifiable Risk Factors

bmi	Diastolic Blood Pressure	Tobacco
Dyslipidemia	Physical Inactivity	Hypertension
Not controlled with medication		

Recommended Protocol

LAB INVESTIGATION
Complete Blood Count, Fasting and Post Prandial Blood Sugar, Lipid Profile, Urea & Creatinine + OtherTests as deemed fit (e.g. HBA1C) Homocysteine Levels Lipoprotein a Neutrophil / Lymphocyte Ratio hsCRP

DIAGNOSTICS AND IMAGING
ECG, Chest X-ray, 2D Echocardiography, Dobutamine Stress Echo TMT ADVANCED Tests- Cardiac CT or Coronary Angiography Thallium Stress Test

REFERRAL
Cardiologist Referral (Urgent)

ADVICE

EDUCATE on lifestyle management and Tobacco Use Cessation

REPEAT VISIT every 3 months or earlier for:– Symptoms of Coronary, Artery Disease, - Any other Surgical or Other Procedur Intervention – Adults of any age if Diabetes, Hypertension, Dyslipidemia or Smoking persists as risk factors

TREATMENT PROTOCOL

Weight control management
It is recommended to consistently encourage weight control through an appropriate balance of physical activity, caloric intake, and formal behavioural programmes when indicated to achieve and maintain a healthy BMI (<25)
Lipid management: To maintain a baseline. Annual control of lipids, glucose metabolism and creatinine are recommended.
Diabetes: HbA1c < 7% (< 53 mmol/mol).
Blood pressure control : < 140/90 mmHg
Smoking / Tobacco Use cessation: No exposure to tobacco in any form or support in smoking cessation.
Psychosocial management: Psychosocial risk factor screening should be considered

In one study by S Vohra, Sethi R. et al[15] AICVD risk scoring model was used and compared with commonly used risk prediction models in contemporary practice. The 10-year risk of major CV events (CVD death, MI or stroke) was calculated in all 314 patients using AICVD risk score. Study concluded that in Indian patients, AICVD risk prediction model has highest prediction potential out of the commonly used risk prediction models.

Measures of Intense Lifestyle Modifications advised as
*   **Reduce Salt intake**: consume no more than 2400 mg of sodium/d; even greater reduction of BP if intake is less than 1500 mg/d.[14]
*   **Regular Exercise:** 3 to 4 sessions per week, lasting on average 40 minutes per session, and involving moderate to vigorous-intensity physical activity.[14]
*   **DASH dietary pattern:** Promote intake of vegetables, fruits, whole grains, low-fat dairy products, poultry, fish, legumes, non-tropical vegetable oils, and nuts; limits intake of sweets, sugar-sweetened beverages and red meats.[14]
*   **Reduce percent of calories from saturated fat and trans fat**, ideally no more than 5%–6% of calories from saturated fat[14]
*   **Quit smoking and tobacco.[9]**
*   **Quit or moderation of Alcohol** (no more than 1 drink for women and 2 for men).[11]
*   **To lose weight and measure waistline-** waist circumference no more than 102 cm for men and 90 cm for women by limiting excess calorie intake
*   **Limit tea and caffeine intake.[16]**
*   Take at least **6-8 hours of sound sleep** daily.[17]

*   **Reduce mental stress[18]** by doing meditation or yoga
*   **Reduce sedentary works and avoid prolonged sitting** for watching Television, working on computer etc.[19]
*   **Social support and spend time with family and friends**: Supportive family and friends can give an emotional or morale boost and can offer practical tips to cope with your condition.

The importance of lifestyle modification in preventive cardiology is also lent support by the results of the Lyon Heart Study.[20] which suggested that dietary modification by itself reduced the risk of coronary heart disease by about half in high risk individuals. Therefore, avoidance of smoking, increased consumption of fruits and vegetables, and moderate activity (along with lipid lowering) should be the cornerstone of prevention of coronary heart disease in all populations worldwide. The special intervention group of MRFIT[21] also comprised of stepped care treatment of hypertension, counselling for cigarette smoking cessation, and dietary advice for lowering serum cholesterol levels.

OBSERVATION AND RESULTS
Table 1: Association of cardinal risk factors with CVD risk category at baseline.

		CVD Risk category at baseline								p-value
		Minimal		Moderate		High		Total		
		N	%	N	%	N	%	N	%	
Medication for HTN	Yes	74	71.8%	110	94.8%	92	98.9%	276	88.5%	**<0.001**
	No	29	28.2%	6	5.2%	1	1.1%	36	11.5%	
	Total	103	100.0%	116	100.0%	93	100.0%	312	100.0%	
Diabetes Mellitus	No Diabetes	53	51.5%	80	69.0%	63	67.7%	196	62.8%	**0.014**
	Controlled on medication	5	4.9%	1	0.9%	0	0.0%	6	1.9%	
	Not controlled	42	40.8%	35	30.2%	29	31.2%	106	34.0%	
	not taking medication	3	2.9%	0	0.0%	1	1.1%	4	1.3%	
	Total	103	100.0%	116	100.0%	93	100.0%	312	100.0%	
Smoking	Current	12	11.7%	13	11.2%	21	22.6%	46	14.7%	**0.039**
	Past	0	0%	0	0%	0	0%	0	0%	
	No	91	88.3%	103	88.8%	72	77.4%	266	85.3%	
	Total	103	100.0%	116	100.0%	93	100.0%	312	100.0%	
Dyslipidaemia	Yes	30	29.1%	66	56.9%	53	57.0%	192	61.5%	0.05
	No	73	70.9%	50	43.1%	40	43.0%	120	38.5%	
	Total	103	100.0%	116	100.0%	93	100.0%	312	100.0%	

Applied χ^2 test of significance.

Among 312 study population, at baseline, the most frequent risk factors were hypertension (88.5%), dyslipidemia (61.5 %) followed by diabetes in whom 40.8% had diabetes not controlled on medication (p value=**0.014)** and least common was smoking 14.7% and 103(33%) patients were in AICVD minimal risk category, 116(37.2%) in moderate risk and 93(29.8 %) in high risk category.

Table 2: Comparison of change in CVD Risk Category after Intense lifestyle modification.

Total		CVD Risk category at baseline			Total
		Minimal	Moderate	High	
		103	116	93	312
Change in CVD Risk after ILSM	Minimal	103	108	1	212
		100.0%	93.1%	1.1%	67.9%
	Moderate	0	8	79	87
		.0%	6.9%	84.9%	27.9%
	High	0	0	13	13
		.0%	.0%	14.0%	4.2%
Total Percent		100.0%	100.0%	100.0%	100.0%

Applied McNemar test for significance. p-value=<0.001; consider highly significant.

After Intense lifestyle modification, out of 103 minimal risk category patients, their AICVD risk was not increased and all of them remained in minimal risk category after 6 months , among 116 moderate risk category patients, 108 (93.1%) patients changed into minimal risk category while 8 (6.9%) patients still remained into moderate risk category but none goes into high risk and among 93 high risk category patients, 13 (4.2%) still remained in high risk category while 80 (84.94%) patients changed into moderate risk category and 1 (1.1%) changed into minimal risk category. These results were **consider highly significant (p-value=<0.001).**

Table 3: Comparison of % change in AICVD risk score after life style modification.

Paired Samples Statistics						
		Mean	N	SD	% mean change	p-value
Pair 1	AICVD Risk Score	8.3365	312	4.21209	27.72%	**<0.001**
	AICVD Risk score after LSM	6.0256	312	2.75809		
Pair 2	Optimal Score	6.4391	312	2.05616	-0.25%	0.317
	Optimal score after LSM	6.4551	312	2.05344		

Applied Wilcoxon Signed Ranks Test for significance (p-value <0.001).

Out of 312 study patients, baseline mean value of AICVD risk score was 8.3±4.2 and after lifestyle modification it decreased upto 6.02±2.75 and there was **27.72% change in mean value in AICVD risk score after lifestyle modification** which was **statically highly significant (p-valve <0.001)** while there is no significant change observed in optimal risk score i.e at baseline 6.43±2.05 and after life style modification 6.45±2.05 and % mean change was -0.25 (p value = 0.317).

DISCUSSION
After life style modification, 93.1%% moderate risk category patients had noted significant drop in their CVD risk category from moderate to minimal risk. Similarly, among high-risk patients, 86.02% patients had noted drop in their risk category from high risk to either moderate (84.94%) or minimal risk (1.07%). This suggest that there is significant (p-value=<0.001) drop in estimated risk of moderate and high-risk patients after intense life style modification.

The reason for this change was due to modification of CVD risk factors due to intense lifestyle modification. Majority of moderate and high risk category patients had uncontrolled hypertension, diabetes and lipids at baseline which was found to be controlled in majority of the patients after lifestyle and dietary modification. The patients who were smoker and/or tobacco chewer at baseline they quit smoking and tobacco after counselling.

Similarly majority of the alcoholics either stopped alcohol intake or did moderation of alcohol consumption. The overweight and obese patients had more AICVD risk score at baseline and their AICVD risk category did not changed significantly after 6 months, this suggested that obesity is the most important risk factors for CVD. The level of physical activity and psychological stress was also improved in study population after counselling about benefits of regular exercise and meditation/ yoga. Those patients who were routinely following advise of dietary and lifestyle modification, they definitely had changes in their AICVD risk score and AICVD risk category.

Similar risk factors were evaluated by J. Shivkumar et al[2]. in their study in which Diabetes mellitus (HR: 2.342; p value <0.001), hypertension (HR: 1.543; p value <0.001), diastolic blood pressure (1.065; p value<0.001), chewing tobacco (HR: 2.01; p value <0.001), smoking (HR:2.277; p value <0.0001) and Dyslipidaemia (1.16; p value<0.001) emerge as the most significant cardiovascular risk parameters in the studied population. Uncontrolled Diabetes (HBA1c > 7.5%) has 2.34 times higher risk while Hypertension has 50% higher risk of CVD Events studied for a period of 7 years. Raised Diastolic Blood Pressure (6.57%) has slightly higher risk than Systolic Blood Pressure (2.5%). Smoking and Chewing Tobacco has over 2 times the higher risk, individuals with Dyslipidaemia have 16% higher risk.

CONCLUSION

Our study concluded that there was significant decrease in AICVD risk score and category due to modification of CVD risk factors by intense lifestyle changes. majority of moderate and high-risk category patients who had more than 1 risk factors of CAD at baseline showed very significant change in their AICVD risk score and category after 6 months of intense lifestyle modification, but the obese or overweight patients with other risk factor do not show such significant change in their CVD risk category. This signifies that obesity is the most important modifiable risk factor of CAD and any of the 4 cardinal risk factors with obesity increases the CVD risk many folds. Thus by applying AICVD risk calculator, patients and physician both can know their current CVD risk status and also gauge the effectiveness of lifestyle modification and therapy on possible future CV events.

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