European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 09, Issue 08, 2022

Original Research Article

Screening of Cardiovascular Risk Factors

Dr. Pradeep Kumar Gupta[1] (Assoc. Prof.), Dr. Pankaj Kumar[2] (Assoc. Prof.), Dr. Bushra Khanam[3] (Assoc. Prof.) & Dr. Sumit Solanki[4] (Senior Resident)

Dept. of Medicine, Index Medical College Hospital & Research Centre, Indore, M.P.[1,2,3&4]

Corresponding Author: Dr. Bushra Khanam

Abstract:

Background: Comprehensive cardiovascular disease risk factor (CVDRF) screening programs are limited in the developing world. Simplifying screening can increase its utility.

Objectives: The present study aims to estimate the burden of CVDRF in volunteers and the yield of newly discovered CVDRF comparing different sites and nationalities using this screening method.

Methods: Voluntary point-of-care CVDRF screening was conducted in Index Medical Hospital and College Follow-up for newly diagnosed diabetes mellitus, hypertension, and dyslipidemia was made 1 month after screening to inquire about physician consultation confirmation of diagnosis and lifestyle changes

Results: A total of 4.128 subjects were screened (43% at Office, 36% at health care facilities, and 22% at Health camps). Subjects were relatively young (38±11 years), predominantly male (75%), and of diverse regions North India : 7%, South India 10%, Central India: 74%, East Indians: 5%, and other Indians 3%). CVDRF were frequent (diabetes mellitus: 32%, hypertension: 31%, dyslipidemia: 69%, current smokers: 21%, obesity: 20%, and central obesity: 24%). Most subjects (85%) had 21 CVDRF, and many (17%) had ≥3 CVDRF. A new diagnosis of diabetes mellitus, hypertension, or dyslipidemia was uncovered in 61.5%, with the highest yield (74.0%) in labor camps. At follow-up of hose with new CVDRF, posave lifestyle changes were reponed in 60%, but only 33% had consulted a doctor of these, diagnosis was confirmed in 63% for diabetes mellitus, 93% for hypertension, and 87% for dyslipidemia.

Conclusions: In these relatively young and different regions of India, diverse cohort. CVDRF burden and yield of screening was high. Screening in these settings is pertinent and can be simplified.

Keywords: Cardiovascular & Risk.

Study Designed: Observational Study.

1. INTRODUCTION

The World Health Organization estimated that in 1998, 78% of the burden of noncommunicable diseases and 85% of cardiovascular disease (CVD) burden arose from low- and middle-income countries [1]. The mortality from ischemic heart disease between 1990 and 2020 has been projected to increase in developing countries by 120% in women and 137% in men [2]. This expected increase is even greater for the Indian Subcontinent and is estimated at 146% in women and 174% in men.

Notably, one-half of the deaths attributable to CVD would occur prematurely in the developing countries compared with only a quarter in the developed countries [3]. In fact, myocardial infarction occurred a decade earlier in India and other South Asian countries Primary prevention of cardiovascular disease rich factors (CVDRF) is a key tool in reducing this epidemic. This entails early detection, lifestyle change, and achieving optimal control of CVDRF. Comprehensive screening pro- grams are required and are an integral part of health care systems in many developed countries. Such comprehensive screening programs can be complex and require substantial health care resources as well as an established health care infrastructure. Even though there is increasing realization of the sharply increasing burden of CVD in the developing countries, systematic screening programs are rare [4]. There is a need for new models of delivering screening that are simple and easily accessible to the population.

IMCHRC established a simple and opportunistic screening program in Indore in the Madhya Pradesh (M.P.) as part of the World Heart Day campaigns (during September and October 2012). Its point-of-care (POC) testing methodology rendered it very accessible for this economically and ethnically diverse population[5].

2. MATERIAL & METHOD

During the World Heart Day celebration of 2022, from the first week of September to the end of October 2022, a free, voluntary CVDRF screening program was offered in Indore screening included 4 Offices The venues for the outpatient health (LC). This was an care facilities, and 3 Health camps opportunistic sample and was not intended to provide a population-based cohort. The sampling strategy was based on convenience for the investigators and for the participants.

Adults aged 18 years or older were invited to take part. The study used a single-page, standardized ques- tionnaire and data form and standardized methodology for measuring blood pressure (BP), height, weight, waist circumference, capillary nonfasting total and high-density lipoprotein (HDL) cholesterol, and capillary hemoglobin. Alc (HbA1c). On-site counseling was delivered by physi- clans. Arterial BP was measured using a standard method: the mean of 2 consecutive measurements was recorded after the subject had rested for 5 min. Blood pressure was measured using Diamond(instrument upper arm BP monitor and weight was measured by Hoffen Weighing Scale Waist circumference was measured, while standing, midway. between the lowest rib and the top of the iliac crest directly on the skin or close-fitting clothing using a non- flexible tape measure attached to a spring balance exerting a force of 75 g 131.

POC machines were used with capillary blood samples. Total cholesterol and HDL were measured by Cardiocheck and HbA1c was measured by Clover Ale Glycosylated Hemoglobin Monitoring System compliant with DCCT (Diabetes Control and Complications Trial) reference method and certified to in- ternational standards (International Federation of Clinical Chemistry

and National Glycohemoglobin Standardization Program) for POC testing during screening and monitoring of diabetes. All POC machines were calibrated before each session.

Major CVDRF were defined as follows: dyslipidemia was defined as a history of known or treated dyslipidemia (receiving cholesterol-lowering medication) or a measured total cholesterol 2200 mg/dl or HDL choles- terol <40 mg/dl. Hypertension was defined as a his tory of known and treated hypertension (receiving antihypertensive medication) or a measured systolic blood pressure ≥140 mm Hg or diastolic blood pressure 290 mm Hg. Obesity was defined as a body mass index of 230.0 kg/m2 using measured height (m) and weight (kg). Diabetes mellitus was defined as a his tory of known and treated diabetes (receiving anti- hyperglycemic medication) or a measured HbA,, 26.5%. Current smoking was defined as using cigarettes or other tobacco products. Central obesity was defined as waist circumference of ≥102 cm in male and 288 cm in female subjects.

At 1-month post-screening, a telephone follow-up call was made to those who were identified as having a new risk factor (mean systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure 290 mm Hg. HbA 26.5%, and total cholesterol 2200 mg/dl). A standardized list of questions were asked to determine whether they had contacted their physicians; had their diagnosis confirmed; and had made dietary, physical activity, or smoking life- style changes.

Consent was taken for screening and use of data for research purposes.

The medical team supervisors as well as the doctors, nurses, and other health workers within the team were given hands-on training on the content of the question- naire, the standardized methods for BP, height, waist, and weight measurements, as well as POC measurements of total and HDL cholesterol and HhA. A confirmative test with the subject's physician was advised.

3. RESULTS

TABLE 1. Baseline Characteristics According to Recruitment Site

	All (N = 4,128)	Health Care Facility (n = 1,490)	Office (n = 1,784)	Health Camps (n = 854)	p Value
Age, yrs	38.4 ± 11.4	40.2 ± 12.0	40.2 ± 10.9	31.5 ± 8.1	<0.001
Male	3,105 (75.4)	976 (65.7)	1,278 (71.8)	851 (99.7)	<0.001
Region					<0.001
North Indians	275 (6.7)	242 (16.2)	33 (1.9)		
South Indians	410 (9.9)	159 (10.7)	234 (13.1)	17 (2.0)	
Central Indians	3,042 (73.7)	949 (63.7)	1,267 (71.0)	826 (96.7)	
East Indians	190 (4.6)	36 (2.4)	150 (8.4)	4 (0.5)	
Others	211 (5.1)	104 (7.0)	100 (5.6)	7 (0.8)	
Occupation					<0.001
Professional	1,125 (27.9)	451 (31.2)	646 (36.3)	28 (3.5)	
Skilled	1,115 (27.7)	244 (16.9)	503 (28.2)	368 (45.8)	
Nonskilled	861 (21.4)	229 (15.89)	260 (14.6)	372 (46.3)	
Housewife	435 (10.80)	197 (13.63)	238 (13.36)		
Retired	77 (1.91)	44 (3.04)	33 (1.85)		
Unemployed/others	416 (10.33)	280 (19.38)	101 (5.67)	35 (4.35)	
Education					<0.001
1–8 Standard	665 (16.2)	238 (16.2)	107 (6.0)	320 (37.5)	
9–12 Standard	1,239 (30.2)	488 (33.2)	471 (26.4)	280 (32.8)	
University/college	1,927 (46.96)	671 (45.71)	1,169 (65.56)	87 (10.2)	
None/not mentioned	273 (6.65)	71 (4.83)	36 (2.02)	166 (19.47)	
Current smoking	850 (20.8)	221 (15.1)	320 (18.0)	309 (36.2)	<0.001
BMI	26.6 ± 4.6	27.3 ± 4.8	27.4 ± 4.3	23.8 ± 3.8	<0.001
Waist	89.8 ± 12.5	87.9 ± 15.1	92.2 ± 11.0	87.5 ± 9.8	0.3
Systolic BP	124.9 ± 16.8	123.3 ± 17.2	125.6 ± 17.5	125.2 ± 14.3	0.01
Diastolic BP	80.9 ± 11.1	79.9 ± 11.2	81.6 ± 11.2	80.8 ± 10.5	0.06
Total cholesterol	163.5 ± 37.7	156.3 ± 38.3	175.2 ± 35.9	151.5 ± 33.4	0.9
HDL cholesterol	42.2 ± 14.2	42.6 ± 16.0	43.7 ± 13.9	38.7 ± 10.2	<0.001
HbA_{1c}	6.5 ± 1.7	6.5 ± 1.8	6.5 ± 1.8	6.1 ± 1.6	<0.001
Framingham CVD 10-year risk score	5.3 ± 7.1	5.7 ± 7.5	6.3 ± 7.6	3.0 ± 4.9	<0.001
Male subjects	5.5 ± 7.3	5.9 ± 7.6	6.5 ± 7.8	3.0 ± 4.9	
Female subjects	4.7 ± 6.0	4.9 ± 6.1	5.6 ± 6.5	-	

Values are mean ± SD or n (%).
BMI = body mass index; BP = blood pressure; CVD = cardiovascular disease; HbA_{1c} = hemoglobin A_{1c}; HDL = high-density lipoprotein;

TABLE 2. Prevalence of CVD Risk Factors (Self-Reported and Uncovered) by Recruitment Site and Region

	Site					Nationality					
	All (N = 4,128)	Health Care Facility (n = 1,490)	Office (n = 1,784)	Health Camps (n = 854)	p Value*	North Indian (n = 275)	South Indians (n = 410)	Central Indians (n = 3,042)	Ex-Indians (n = 190)	Other (n = 211)	p Value*
Diabetes	1,303 (31.6)	539 (36.2)	619 (34.7)	145 (17.0)	<0.001	127 (46.2)	120 (29.3)	965 (31.7)	42 (22.1)	49 (23.2)	0.002
Hypertension	1,261 (30.6)	432 (29.0)	623 (34.9)	206 (24.1)	0.003	83 (30.2)	94 (22.9)	959 (31.5)	74 (39.0)	51 (24.2)	<0.001
Dyslipidemia	2,828 (68.5)	1,036 (69.5)	1,218 (68.3)	574 (67.2)	<0.001	182 (66.2)	284 (69.3)	2,160 (71.0)	101 (53.2)	101 (47.9)	<0.001
BMI†					<0.001						<0.001
Overweight	1,711 (41.9)	622 (42.5)	838 (47.5)	251 (29.4)		92 (34.3)	170 (41.9)	1,300 (43.1)	76 (40.4)	73 (35.8)	
Obese	799 (19.6)	349 (23.9)	404 (22.9)	46 (5.4)		125 (46.6)	166 (40.9)	426 (14.1)	30 (16.0)	52 (25.5)	
Central obesity‡	927 (24.0)	389 (30.5)	468 (26.8)	70 (8.3)	0.085	115 (55.8)	160 (43.5)	539 (18.5)	51 (27.9)	62 (33.0)	<0.001
Smoking					0.067						<0.001
Previous	305 (7.4)	146 (10.0)	131 (7.4)	28 (3.3)		19 (7.2)	35 (8.6)	223 (7.4)	10 (5.3)	18 (8.6)	
Current	850 (20.8)	221 (15.1)	320 (18.0)	309 (36.2)		39 (14.7)	111 (27.3)	646 (21.3)	23 (12.2)	31 (14.8)	
Family history of DM	1,472 (39.3)	620 (48.0)	739 (43.7)	113 (14.8)	<0.001	130 (55.8)	160 (42.4)	1,063 (38.3)	52 (29.2)	67 (36.2)	<0.001
Family History of CVD	1,052 (28.7)	417 (34.2)	562 (33.4)	73 (9.5)	<0.001	94 (42.7)	114 (30.2)	719 (26.4)	64 (36.6)	61 (34.5)	<0.001

Values are n (%).
DM = diabetes mellitus; other abbreviations as in Table 1.
*The p values are adjusted for age and sex.
†Overweight = 25 to 29.9; obese = 30+.
‡Waist: male: ≥102 cm, female: ≥88 cm.

TABLE 3. Uncovered Diabetes Mellitus, Hypertension, and Dyslipidemia Compared With Study Prevalence by Recruitment Site and Region

	Site					Region					
	All	Health Care Facility	Office	Health Camps	p Value	North Indians	South Indians	Central Indians	Ex-Indians	Other	p Value
Diabetes (new/all)	677/1,303 (51.9)	243/539 (45.1)	325/619 (52.5)	109/145 (75.2)	<0.001	49/127 (38.6)	58/120 (48.3)	515/965 (53.4)	31/42 (73.8)	24/49 (49.0)	0.002
Hypertension (new/all)	558/1,261 (44.3)	134/432 (31.0)	269/623 (43.2)	155/206 (75.2)	0.003	12/83 (14.5)	23/94 (24.5)	474/959 (49.4)	32/74 (43.2)	17/51 (33.5)	<0.001
Dyslipidemia (new/all)	2,004/2,828 (70.9)	668/1,036 (64.5)	799/1,218 (65.6)	537/574 (93.6)	<0.001	80/182 (44.0)	193/284 (68.0)	1,588/2,160 (73.5)	70/101 (69.3)	73/101 (72.3)	<0.001
Any "new" RF (new/overall)	2,538/4,128 (61.5)	839/1,490 (56.3)	1,047/1,784 (59.8)	632/854 (74.0)	0.003	112/275 (40.7)	229/410 (55.9)	1,993/3,042 (65.5)	102/190 (53.7)	87/211 (41.2)	0.058

Values are n/n (%).
RF = risk factor(s).

The baseline character- istics according to recruitment site are described in Table 1. Age was lowest in the LC, where almost all were male (99.7%) and non-Indian nationals (100%). Current smoking status was highest in LC at 36% compared with other sites (15% to 21 %), and they also had the lowest body mass index, HDL cholesterol, and HbA,, levels, as well as mean 10-year Framingham CVD risk scores.

The overall mean 10-year Framingham CVD risk score in male subjects was 5.5% and it was highest (7.2%) in Prevalence of risk factors and risk burden. The prevalence of CVDRF (self-reported and uncovered) according to site are summarized in Table 2. Of those screened, 3,465 (85%) had ≥1CVDRF and 693 (17%) had ≥3 CVDRF. Overall, the screened cohort had a study prevalence of diabetes of 32%, hyper- tension of 31%, and dyslipidemia of 69%. Body habitus status of overweight was seen in 42%, obesity in 20%, and central obesity in 24%. Current smoking was reported in 21% of the cohort and an additional 7.4% were ex- smokers. Current smoking was lowest in North Indians at 15% and highest in Central Indians at 27%. Family history of diabetes and CVD was present in 39% and 29%, respectively, and was highest among North Indians nationals also had the highest rates of obesity both by body mass index and waist circumference.

Uncovered CVD risk factors and screening yield Table 3 reports newly uncovered risk factors. Of all the diabetics in the cohort, 677 (52%) were previously un- aware of their risk factor. Similarly, 558 (44%) of hyper- tensive and 2,004 (71%) of dyslipidemia subjects were not.
The yield of detecting a new risk factor was higher in male subjects at 2,031 (65.4%) than in female subjects at 354 (34.8%). In a multivariate model including age, sex, obesity, and smoking, only age (per 10 years) was nega- tively associated (odds ratio [OR]: 0.834; 95% confidence interval [CI]: 0.784 to 0.886; $p < 0.001$) and male sex was positively associated (OR: 3.441; 95% CI: 2.930 to 4.042: $p< 0.001$) with the detection of a new risk factor at screening. The yield did not increase when those younger than 30 years of age were excluded.

Control of known CVDRF

Among those with prior diagnosis of diabetes mellitus, 205 (33%) had HbA, of <7%, 209 (34%) between 7% and 9%, and 203 (33%) >9%. There was no significant difference between regions Among those previously diagnosed to have hypertension, 290 (48%) had a BP <140/90 mm Hg. 211 (35%) between 140/90 and 160/100 mm Hg, whereas 99 (17%) were >160/100 mm Hg, BP control (BP <140/90 mm Hg) was worse in the North Indians than in East Indians (44% vs. 74% p=0.004). Total cholesterol of <200 mg/dl was recorded in 613 (75%) of those with previous diagnosis of dyslipi- demia, and this was significantly higher in Central Indians than in North Indians (87% vs. 58%; p=0.046).

Follow-up of the new CVD risk factors

Table 4 shows the follow-up of new CVDRF by site. We were able to contact >80% of subjects with new diabetes, hypertension, or dyslipidemia. Subsequent follow-up consultation with a physician had occurred in approximately one-third of patients. Confirmation of diagnosis by a physician was established in 63% for dia- betes, 93% for hypertension, and 87% for dyslipidemia. Self-reported lifestyle change (general questions regarding change in food habits, physical activity, and tobacco cessation) occurred in 56% to 66% were known to them, for example, looking for diabetes in those with hypertension; and 2) they would get some de of control of their lown CVDBF So this programs may not be a "pure" screening program, but is a seful method of increasing CVDRF awe and cool This is particularly relevant where health care systems are patchy and do not cover the whole population.
We found a high burden of CVDRF inspective of se of seeing, although there was consid enable heterogeneity. There was also a high screening yield in that 21 new CVDR was uncovered in one-half of all subjects, regardless of rationality or she. This was highest in the LC (74%) where 3 in + of diabetic or hyperve subjects and nearly 9 in 10 dyslipidemics were not aware of their rak factor. Notably, around 2 n 3 of subjects with a newly discovered risk fator at screening did not seek medical mention within 1 month of follow-up, but among those that did, the CVDRF was confimed in the murky
Younger age and male sex increased the dunce of having a new risk factor detected. This suggests that it is in some grammanal programs for example in United Kingdom [6]. Although the yield of screening was higher in male subjects, it was still substantial (39%) in male subjects. In addition, obesity and smoking sta did not aber the odds of detecting another new risk factor at screening, hence king screening to obese subjects and smokers is not beneficial.
The mean overall Framingham 10-year risk score for CVD events 5.3%, which is compable to 4.8% in the comprehensive North Indian population [7]. This may be madenly kw due to the

heavy relance of the Framingham risk score on age and the fact that both the Wegaya and this cohon are relatively young, In addition, the Framingham risk score is known underestimate risk in populators where the cascular risk bunden or prevalence of diabetes is high, such as in the UAE. The high CVDRF burden in this cohon is shown by the fact that 85% of our seatedly young cohort had 21CVDRF. This could be compared with 21 risk factor in 80% in men and 71% of women in the North Indian and Centrale adult population using mar criteria [8]. Our estimates are also consistent with the recently reported Africa Middle East Cadoula Epidemiological Study, where the vast majority of subjects (92%) had 21mochfable cadicular risk factor, and approximately one-half (53%) had ≥3, a finding that was observed in both sexes and across urban and rural centers [9]. This further strengthens the justifications wc CVD screening in this population.

Screening can be sure-terive and difficult to admin, rates as low as 32% are achieved in some Westersening programs (20). Screening methods that are more accessible and rapidly deployed such as POC sting can incase the uptake and reduce the cost of screening.

4. DISCUSSION

The simple method and high accessi hday used in the camera study is especially beneficial in populations where the burden of CVRF is high. The health care-seeking and likestyle behaviors post screening an also importam in uns of influencing outcomes. Ideally individuals diagnosed wah new k factors would vot a physician to confirm the diagnosis and cool the risk factor through lifestyle changes, and sequined, by medication. Only with control of the risk factor would the risk of CVD events decrease[10]. Is this study, an follow-up, approodmately 2 in 3 individuals reported to have changed their style, but only 1 in 3 had consulted a physician. Whereas the self-reported change in may reflect a change in knowledge and wide, style is not plan the way low of coaling wah their physician is clearly unacceptable if we want to control CVDRE Heath case-seeking behavior of asymptomatic individuals in particular is a complex mix of social, psychological, cultural and biomedical factors (25). To make screening a more effective tool, however, farther studies are needed to understand this and to incase the link to health case system. Camerely in India access to care and insurance coverage for non-nationals is slowly evolving but many non-nationals remain uninsured or underinsured.

When the diagnosis of hypension and dyslipide mia were confirmed in about 90% of subjects during consultation with their physicians, the diagnosis of diabetes was confirmed in only 2%. This and be because of the difers that the physicians could have used for confirmation lasing glucose, post-prandiale alglucose tolerance test, or HbA, on the other hand, could also be due to the inaccuracies from the use of POC method[11].

Among subjects with a previous diagnosis of risk factors, diabetes was uncontrolled in 2 of 3, hypertension 1 in 2, and hypercholesterolemia in 1 in 4. The poor conta was universal for diabetes but was significantly worse among South Asians for hypertension as well as hyper-cholesalers. The differences could be due to access to and cost of health case, but this needs to be further investigated.

Strengths and limitations

This study looked at the usefulness of screening for CVDBF in a much society. The anngh of this study is the al-life sening the inclusion of all components of society and the large number of subjects screened in several cities! settings in the india. As far as we know, this is the largest

wady looking at croming in a multiethnic population in India. The study also included different socioeconomic categories, including the migrants and unskilled workers. However, there were several limitations of the study. Female subjects represented only 25% of the cohort, which mirrors the low female proportion of the adult population demographics, and is comitent with the 2001 population estimate from the Office of Registrar General & Cencus Commissioner Also, this was a convenience sample; therefore, the results are not generalizable to the Indian population as would be the results of a population-based, random sampling method. However, whereas this study cannot report standardized population prevalence rates, it provides an indication of the relative CVDRF burden between nation- alities and segments of society.

A possible limitation was that we used POC testing for total cholesterol, HDL, and HbA. Although there has been some doubt of their accuracy, especially for HbA this method is advantageous due to the increased accessi bility and faster turnaround, with real-time feedback of results [12]. There has been increasing evidence of its accuracy and increasing use in primary health care setting for screening as well as monitoring 1271. For instance, the Ontario Health Technology Assessment Series 2014 re- ported that pooled results from 5 studies showed a positive correlation between POC HbA,, testing and laboratory HhA, measurement (correlation coefficient: 0.967, 95% CI: 0.960 to 0.973). In our study, the staff using the POC machines received training and performed quality control to reduce the error rate.

Although this study followed up at least 1 month after screening, more details of the lifestyle changes and whether it was sustained, would have been desirable as would further details about their failure to seek help once the risk factor who identified. For instance, the insurance status of the subjects was unfortunately not collected. Further research should look at these aspects as well as the cost and clinical effectiveness of such a screening program.

5. CONCLUSION

In these relatively young and different regions of India, diverse cohort, the CVDRF burden is high, with 85% subjects having ICVDRF. The high CVDRF burden is present at all screening sites. The yield from screening was high irrespective of site 40% and 70% of the CVDRF newly uncovered at screening. The yield was higher in male subjects (65%) and in LC subjects (74%). However it was not reduced when those younger than 30 years were excluded and was also substantial in female subjects (35%). This study suggests that screening is beneficial in all adults.

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