

Opportunistic Screening for CVD Risk Factors

The Dubai Shopping for Cardiovascular Risk Study (DISCOVERY)

Afzalhussein Yusufali*, Nooshin Bazargani*, Khalifa Muhammed†, Ahmed Gabroun‡, Amna AlMazrooei§, Amrish Agrawal||, Arif Al-Mulla*, Cother Hajat¶, Fahad Baslaib†, Jessy Philip*, Pradeep Gupta#, Sherif Bakir†, Suresh Krishnan*, Wael Almahmeed**, Alawi Alsheikh-Ali**

Dubai, Fujairah, Al Ain, Ras al-Khaimah, and Abu Dhabi, United Arab Emirates

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 4 shopping malls, 9 health care facilities, and 3 labor camps in 5 cities in the United Arab Emirates. 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 malls, 36% at health care facilities, and 22% at labor camps). Subjects were relatively young (38 ± 11 years), predominantly male (75%), and of diverse nationalities (United Arab Emirates: 7%, other Arabs: 10%, South Asians: 74%, other Asians: 5%, and other nationalities: 5%). CVDRF were frequent (diabetes mellitus: 32%, hypertension: 31%, dyslipidemia: 69%, current smokers: 21%, obesity: 20%, and central obesity: 24%). Most subjects (85%) had ≥ 1 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 those with new CVDRF, positive lifestyle changes were reported 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 this relatively young and ethnically diverse cohort, CVDRF burden and yield of screening was high. Screening in these settings is pertinent and can be simplified.

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 Middle East countries 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 [1]. In fact, myocardial infarction occurred a decade earlier in the Middle East and South Asia than in Western Europe and North America in the global case-control INTERHEART (INTERHEART: A Global Study of Risk Factors for Acute Myocardial Infarction) [3] and the regional Gulf RACE (Registry of Acute Coronary Events) [4]. This has considerable economic and social implications on the family and the nation.

Primary prevention of cardiovascular disease risk factors (CVDRF) is a key tool in reducing this epidemic. This entails early detection, lifestyle change, and achieving optimal control of CVDRF. Comprehensive screening programs 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 [5]. There is a need for new models of delivering screening that are simple and easily accessible to the population.

The DISCOVERY (Dubai Shopping for Cardiovascular Risk Study) established a simple and opportunistic screening program in 5 cities in the United Arab Emirates (UAE) 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. It is a

The authors report no relationships that could be construed as a conflict of interest.

This work was funded by the Emirates Cardiac Society, Majid Al Futtaim Foundation, Novartis, and Omron Healthcare Co. Ltd. From the *Dubai Heart Centre, Dubai Hospital, Dubai Health Authority, Dubai, United Arab Emirates; †Rashid Hospital, Dubai Health Authority, Dubai, United Arab Emirates; ‡Canadian Specialist Hospital, Dubai, United Arab Emirates; §PHC, Dubai Health Authority, Dubai, United Arab Emirates; ||Fujairah Hospital, Fujairah, United Arab Emirates; ¶United Arab Emirates University, Al Ain, United Arab Emirates; #Saif and IBHO Hospital & RAKMSU, Ras al-Khaimah, United Arab Emirates; and the **Institute of Cardiac Sciences, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates. Correspondence: A. Yusufali (ahyusufali@dha.gov.ae or amyusufali@emirates.net.ae).

GLOBAL HEART
© 2015 World Heart Federation (Geneva). Published by Elsevier Ltd. Open access under CC BY-NC-ND license. VOL. 10, NO. 4, 2015 ISSN 2211-8160 <http://dx.doi.org/10.1016/j.gheart.2015.04.008>

unique program, in that it includes all components of the UAE population. A pilot phase of the study estimated that around one-third of relatively young and ethnically diverse mall shoppers in a major city in the UAE (Dubai) had ≥ 1 modifiable CVDRF that was previously undetected [6].

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. There have been no national systematic random sample risk factor surveys in this population and this study, to some extent, helps fill that gap. We also assess the impact of the new diagnosis on the volunteer's lifestyle and health care-seeking behavior.

METHODS

During the World Heart Day celebration of 2012, from the last week of September to the end of October 2012, a free, voluntary CVDRF screening program was offered in 5 major cities of the UAE—Dubai, Abu Dhabi, Sharjah, Fujairah, and Ras al Khaimah. The venues for the screening included 4 shopping malls, 9 outpatient health care facilities, and 3 labor camps (LC). This was an 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 questionnaire 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 A1c (HbA_{1c}). On-site counseling was delivered by physicians. Arterial BP was measured using a standard method: the mean of 2 consecutive measurements was recorded after the subject had rested for 5 min [7]. Blood pressure was measured using Omron (Kyoto, Japan) upper arm BP monitor M10-IT with international protocol and British Hypertension Society protocol clinical validation. Weight was measured by Omron Body Composition Monitor Bf-511, a clinical validation and Technischer Überwachungs-Verein-certified medical wellness product. 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 [3].

POC machines were used with capillary blood samples. Total cholesterol and HDL were measured by Cardiocheck and HbA_{1c} was measured by Clover A1c Glycosylated Hemoglobin Monitoring System (EuroMedix, Leuven, Belgium) compliant with DCCT (Diabetes Control and Complications Trial) reference method and certified to international standards (International Federation of Clinical Chemistry and National Glycohemoglobin Standardization Program) for POC testing during screening and monitoring

of diabetes [8]. 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 ≥ 200 mg/dl or HDL cholesterol < 40 mg/dl [9]. Hypertension was defined as a history of known and treated hypertension (receiving antihypertensive medication) or a measured systolic blood pressure ≥ 140 mm Hg or diastolic blood pressure ≥ 90 mm Hg [10]. Obesity was defined as a body mass index of ≥ 30.0 kg/m² using measured height (m) and weight (kg) [11]. Diabetes mellitus was defined as a history of known and treated diabetes (receiving antihyperglycemic medication) or a measured HbA_{1c} $\geq 6.5\%$ [12]. Current smoking was defined as using cigarettes or other tobacco products [13]. Central obesity was defined as waist circumference of ≥ 102 cm in male and ≥ 88 cm in female subjects [14].

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 ≥ 90 mm Hg, HbA_{1c} $\geq 6.5\%$, and total cholesterol ≥ 200 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 lifestyle changes.

Consent was taken for screening and use of data for research purposes. Ethical approval from the Medical Research Committee of Dubai Health Authority was obtained (Ref#MRC-07/2012_09).

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 questionnaire, the standardized methods for BP, height, waist, and weight measurements, as well as POC measurements of total and HDL cholesterol and HbA_{1c}. A confirmative test with the subject's physician was advised.

Statistical methods

Stata software (version 10, StataCorp LP, College Station, Texas) was used for all analyses. The prevalence of CVDRF in the study cohort was estimated using the number of known and new cases as the numerator and the total number of study participants without missing information for that risk factor as the denominator. Comparisons of prevalence rates were made between recruitment sites and between nationalities with statistical significance at $p < 0.05$ after adjusting for age and sex.

RESULTS

We screened 4,128 subjects with a mean age \pm SD of 38 ± 11 years, of whom 3,105 (75%) were male. Screening was undertaken at 3 site categories: 1,775 (43%) in 4 malls; 1,486 (36%) in 9 government or private health care

facilities; and 867 (21%) in 3 LC. The baseline characteristics according to recruitment site are described in Table 1. Age was lowest in the LC, where almost all were male (99.7%) and non-UAE 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_{1c} 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 UAE nationals.

Prevalence of risk factors and risk burden

The prevalence of CVDRF (self-reported and uncovered) according to site and nationality are summarized in Table 2. Of those screened, 3,465 (85%) had ≥ 1 CVDRF, and 693 (17%) had ≥ 3 CVDRF. Overall, the screened

cohort had a study prevalence of diabetes of 32%, hypertension 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 UAE nationals at 15% and highest in other Arabs at 27%. Family history of diabetes and CVD was present in 39% and 29%, respectively, and was highest among UAE nationals. UAE 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 unaware of their risk factor. Similarly, 558 (44%) of hypertensive and 2,004 (71%) of dyslipidemia subjects were not

TABLE 1. Baseline Characteristics According to Recruitment Site

	All (N = 4,128)	Health Care Facility (n = 1,490)	Malls (n = 1,784)	Labor 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
Nationality					<0.001
UAE	275 (6.7)	242 (16.2)	33 (1.9)		
Other Arabs	410 (9.9)	159 (10.7)	234 (13.1)	17 (2.0)	
South Asians	3,042 (73.7)	949 (63.7)	1,267 (71.0)	826 (96.7)	
Other Asians	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 yrs	665 (16.2)	238 (16.2)	107 (6.0)	320 (37.5)	
9–12 yrs	1,239 (30.2)	488 (33.2)	471 (26.4)	280 (32.8)	
Trade school/college or university	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; UAE = United Arab Emirates.

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

	Site				p Value*	Nationality					p Value*
	All	Health Care Facility	Malls	Labor Camps		UAE	Other Arabs	South Asians	Other Asians	Other	
	(N = 4,128)	(n = 1,490)	(n = 1,784)	(n = 854)		(n = 275)	(n = 410)	(n = 3,042)	(n = 190)	(n = 211)	
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 Nationality

	Site				p Value	Nationality					p Value
	All	Health Care Facility	Malls	Labor Camps		UAE	Other Arabs	South Asians	Other Asians	Other	
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 (33.3)	<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)	1,067/1,784 (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); UAE = United Arab Emirates.

aware of their respective diagnosis prior to screening. The overall yield of screening as measured by any newly uncovered CVDRF (diabetes, hypertension, or dyslipidemia) during screening was 62% and was significantly higher in LC (74%) where 75% of diabetic, 75% of hypertensive, and 94% of dyslipidemia subjects were unaware of their diagnoses.

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 negatively 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_{1c} of <7%, 209 (34%) between 7% and 9%, and 203 (33%) >9%. There was no significant difference between nationalities. 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 South Asians than in UAE nationals (44% vs. 74%; $p = 0.004$). Total cholesterol of <200 mg/dl was recorded in 613 (75%) of those with previous diagnosis of dyslipidemia, and this was significantly higher in UAE nationals than in Other Asians (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 and nationality. 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 diabetes, 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%.

DISCUSSION

This study describes a simple and accessible screening methodology delivered where the population is conveniently available, that is, at malls, LC, and health care centers. The subjects are not required to be fasting; they undergo a short, 1-page questionnaire; basic anthropometric and BP measurements; and POC capillary testing for HbA_{1c}, total cholesterol, and HDL cholesterol with an onsite physician for counseling. We screened all comers including those with pre-existing CVDRF, for 2 major reasons: 1) they might have other CVDRF beside those that

TABLE 4. Follow-Up of "New" CVD RF by Recruitment Site and Nationality

	Site				Nationality					p Value
	All	Health Care Facility	Malls	Labor Camps	UAE	Other Arabs	South Asians	Other Asians	Other	
New diabetes	677	243	325	109	49	58	515	31	24	
Contacted	608 (88.6)	203 (82.2)	308 (93.6)	97 (88.2)	44 (88.0)	52 (85.3)	469 (90.4)	30 (96.8)	13 (52.0)	<0.001
Consultation	201 (33.1)	69 (34.0)	105 (34.1)	27 (27.8)	22 (50.0)	25 (48.1)	139 (29.6)	10 (33.3)	5 (38.5)	0.008
Confirmation*	126 (62.7)	35 (50.7)	68 (64.8)	23 (85.2)	8 (36.4)	3 (12.0)	101 (72.7)	9 (90.0)	5 (100.0)	0.021
Change of lifestyle	343 (56.4)	108 (53.2)	182 (59.1)	53 (54.6)	11 (25.0)	10 (19.2)	285 (60.8)	26 (86.7)	11 (84.6)	<0.001
New hypertension	558	134	269	155	12	23	474	32	17	
Contacted	468 (83.3)	100 (75.2)	241 (88.0)	127 (81.9)	10 (71.4)	18 (78.3)	401 (84.2)	29 (90.6)	10 (58.8)	<0.001
Consultation	160 (34.2)	38 (38.0)	87 (36.1)	35 (27.6)	4 (40.0)	4 (22.2)	139 (34.7)	10 (34.5)	3 (30.0)	0.842
Confirmation*	149 (93.1)	36 (94.7)	83 (95.4)	30 (85.7)	2 (50.0)	4 (100.0)	130 (93.5)	10 (100.0)	3 (100.0)	0.812
Change of lifestyle	303 (64.7)	66 (66.0)	176 (73.0)	61 (48.0)	6 (60.0)	11 (61.1)	255 (63.6)	21 (72.4)	10 (100.0)	0.157
New dyslipidemia†	444	120	269	55	24	54	313	30	23	
Contacted	372 (83.8)	92 (76.7)	234 (87.0)	46 (83.6)	15 (62.5)	43 (79.6)	269 (85.9)	27 (90.0)	18 (78.3)	<0.001
Consultation	124 (33.3)	26 (28.3)	87 (37.2)	11 (23.9)	5 (33.3)	19 (44.2)	91 (33.8)	6 (22.2)	3 (16.7)	0.195
Confirmation*	108 (87.1)	21 (80.8)	77 (88.5)	10 (90.9)	3 (60.0)	10 (52.6)	86 (94.5)	6 (100.0)	3 (100.0)	0.359
Change of lifestyle	246 (66.1)	56 (60.9)	165 (70.5)	25 (54.4)	3 (20.0)	12 (27.9)	200 (74.4)	19 (70.4)	12 (66.7)	<0.001

Values are n or n (%).

*In those who consulted their physicians.

†Total cholesterol ≥200 mg/dl.

were known to them, for example, looking for diabetes in those with hypertension; and 2) they would get some idea of control of their known CVDRF. So this program may not be a “pure” screening program, but is a useful method of increasing CVDRF awareness and control. This is particularly relevant where health care systems are patchy and do not cover the whole population.

We found a high burden of CVDRF irrespective of site of screening and nationality, although there was considerable heterogeneity. There was also a high screening yield in that ≥ 1 new CVDRF was uncovered in one-half of all subjects, regardless of nationality or site. This was highest in the LC (74%) where 3 in 4 of diabetic or hypertensive subjects and nearly 9 in 10 dyslipidemias were not aware of their risk factor. Notably, around 2 in 3 of subjects with a newly discovered risk factor at screening did not seek medical attention within 1 month of follow-up, but among those that did, the CVDRF was confirmed in the majority.

Younger age and male sex increased the chance of having a new risk factor detected. This suggests that it would not be effective to limit screening to older adults as is seen in some governmental programs for example in United Kingdom [15]. Although the yield of screening was higher in male subjects, it was still substantial (35%) in female subjects. In addition, obesity and smoking status did not alter the odds of detecting another new risk factor at screening, hence limiting screening to obese subjects and smokers is not beneficial either.

The mean overall Framingham 10-year risk score for CVD events was 5.3%, which is comparable to 4.8% in the comprehensive Weqaya study of the Abu Dhabi national population [16]. This may be misleadingly low due to the heavy reliance of the Framingham risk score on age and the fact that both the Weqaya and this cohort are relatively young. In addition, the Framingham risk score is known to underestimate risk in populations where the cardiovascular risk burden or prevalence of diabetes is high, such as in the UAE [17]. The high CVDRF burden in this cohort is shown by the fact that 85% of our relatively young cohort had ≥ 1 CVDRF. This could be compared with ≥ 1 risk factor in 80% in men and 71% of women in the U.S. Hispanic and Latino adult population in the HCHS/SOL (Hispanic Community Health Study/Study of Latinos) using similar criteria [18]. Our estimates are also consistent with the recently reported Africa Middle East Cardiovascular Epidemiological Study, where the vast majority of subjects (92%) had ≥ 1 modifiable cardiovascular risk factor, and approximately one-half (53%) had ≥ 3 , a finding that was observed in both sexes and across urban and rural centers [19]. This further strengthens the justification for systematic CVD screening in this population.

Screening can be resource-intensive and difficult to administer; rates as low as 32% are achieved in some Western screening programs [20]. Screening methods that are more accessible and rapidly deployed such as POC testing can increase the uptake and reduce the cost of screening. POC testing has been debated vigorously, but its

use has been escalating with increasing reports of its reliability, cost-effectiveness and its ability to increase patient satisfaction [21,22]. Other means of simplifying screening include the use of touch screens in general practice reception areas in Australia [23] and training and equipping lay people to carry out screening in people’s homes in Kerala, India [24]. The simple method and high accessibility used in the current study is especially beneficial in populations where the burden of CVRF is high.

The health care-seeking and lifestyle behaviors post-screening are also important in terms of influencing outcomes. Ideally individuals diagnosed with new risk factors would visit a physician to confirm the diagnosis and control the risk factor through lifestyle changes, and if required, by medication. Only with control of the risk factor would the risk of CVD events decrease. In this study, at follow-up, approximately 2 in 3 individuals reported to have changed their lifestyle, but only 1 in 3 had consulted a physician. Whereas the self-reported change in lifestyle may reflect a change in knowledge and attitude, it is not clear if lifestyle behavior had also improved. Also the very low rate of consulting with their physician is clearly unacceptable if we want to control CVDRF. Health care-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, further studies are needed to understand this and to increase the link to health care systems. Currently in UAE, access to care and insurance coverage for non-nationals is slowly evolving but many non-nationals remain uninsured or underinsured.

Whereas the diagnosis of hypertension and dyslipidemia were confirmed in about 90% of subjects during consultation with their physicians, the diagnosis of diabetes was confirmed in only 62%. This could be because of the different tests that the physicians could have used for confirmation (fasting glucose, post-prandial glucose, oral glucose tolerance test, or HbA_{1c}); on the other hand, it could also be due to the inaccuracies from the use of POC method for HbA_{1c}.

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 control was universal for diabetes but was significantly worse among South Asians for hypertension as well as hypercholesterolemia. The differences could be due to access to and cost of health care, but this needs to be further investigated.

Strengths and limitations

This study looked at the usefulness of screening for CVDRF in a multiethnic society. The strength of this study is the real-life setting, the inclusion of all components of society, and the large number of subjects screened in several cities/settings in the UAE. As far as we know, this is the largest study looking at screening in a multiethnic population in

the UAE. 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 consistent with the 2010 population estimate from the National Bureau of Statistics of UAE [26]. Also, this was a convenience sample; therefore, the results are not generalizable to the UAE 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 nationalities and segments of society.

A possible limitation was that we used POC testing for total cholesterol, HDL, and HbA_{1c}. Although there has been some doubt of their accuracy, especially for HbA_{1c}, this method is advantageous due to the increased accessibility and faster turnaround, with real-time feedback of results [21]. There has been increasing evidence of its accuracy and increasing use in primary health care setting for screening as well as monitoring [27]. For instance, the Ontario Health Technology Assessment Series 2014 reported that pooled results from 5 studies showed a positive correlation between POC HbA_{1c} testing and laboratory HbA_{1c} measurement (correlation coefficient: 0.967, 95% CI: 0.960 to 0.973) [28]. 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 was 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.

CONCLUSIONS

In this relatively young and ethnically diverse cohort, the CVDRF burden is high, with 85% subjects having ≥ 1 CVDRF. The high CVDRF burden is present at all screening sites and among all nationalities. The yield from screening was high irrespective of site or nationality with between 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 in the UAE.

ACKNOWLEDGMENTS

For their support of the study, the authors thank Fathimunnissa Hussain, Evangeline Palos, Jiji Kumara, Shirley Mohan, Naser Jamil, Zaher Omar Othman, Charito Corcuera, Elsie D'cunha, Bindu Baiju, Manju George,

Preetha Daniel, Marites Salvador, Noor Talib, Juliet Sales, Salma Abdelmunem, Armelita Raso, Shiakha Ahmed, Muzammil Khambati, Hussein Adamji, Mohamedhassan Abid, Shaija Abubaker, Fatima Mohamed, Saroor Ahmed, Mohamed Aashiq, Sulaiman Foudah, A. Aboobaker, Irene Danalag, Vivian Arellano, Bini Stella, V.S. Sajith, Jameelah Dominguez, Osama Mahmood, and Madeline Alcos.

REFERENCES

1. The World Health Report. Making a Difference. Geneva: World Health Organization; 1999.
2. Murray CJL, Lopez AD, editors. The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability From Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020. Boston, MA: Harvard School of Public Health; 1996.
3. Yusuf S, Hawken S, Ounpuu S, et al, for the INTERHEART Study Investigators. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2004;364:937–52.
4. Awad HH, Zubaid M, Alsheikh-Ali AA, et al. Comparison of characteristics, management practices, and outcomes of patients between the global registry and the gulf registry of acute coronary events. *Am J Cardiol* 2011;108:1252–8.
5. Celermajer DS, Chow CK, Marijon E, Anstey NM, Woo KS. Cardiovascular disease in the developing world: prevalences, patterns, and the potential of early disease detection. *J Am Coll Cardiol* 2012;60:1207–16.
6. Krishnan SN, Yusufali AH, Bazargani N, et al. Undiagnosed and uncontrolled cardiovascular risk factors are common among shoppers: the Dubai shopping for cardiovascular risk study (DISCOVERY) (abstr). *Circulation* 2012;125:P707.
7. Mancia G, De Backer G, Dominiczak A, et al. 2007 guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Eur Heart J* 2007;28:1462–536.
8. American Diabetes Association. Standards of medical care in diabetes—2010. *Diabetes Care* 2010;33(Suppl 1):S11–61.
9. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. *Circulation* 2002;106:3143–421.
10. Chobanian AV, Bakris GL, Black HR, et al, for the National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, National High Blood Pressure Education Program Coordinating Committee. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA* 2003;289:2560–72.
11. National Heart, Lung, and Blood Institute. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report. NIH Publication 98–4083. Bethesda, MD: National Heart, Lung, and Blood Institute, 1998.
12. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2010;33(Suppl 1):S62–9.
13. Teo KK, Hawken S, Pandey MR, et al, for the INTERHEART Study Investigators. Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: a case-control study. *Lancet* 2006;368:647–58.
14. National Cholesterol Education Program. Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (ATP III Final Report). Bethesda, MD: National Institutes of Health; 2002. Publication No. 02-5215.
15. British Cardiac Society, British Hypertension Society, Diabetes UK, HEART UK, Primary Care Cardiovascular Society, Stroke Association.

- JBS 2: Joint British Societies' guidelines on prevention of cardiovascular disease in clinical practice. *Heart* 2005;91(Suppl 5):v1–52.
16. Hajat C, Harrison O, Al Siksek Z. Weqaya: a population-wide cardiovascular screening program in Abu Dhabi, United Arab Emirates. *Am J Public Health* 2012;102:909–14.
 17. Price HC, Cull CA, Coleman RL, et al. Framingham equations underestimate cardiovascular risk compared with the UKPDS risk engine in people with type 2 diabetes. *Diabet Med* 2007;24(Suppl 1):55.
 18. Daviglius ML, Talavera GA, Avilés-Santa ML, et al. Prevalence of major cardiovascular risk factors and cardiovascular diseases among Hispanic/Latino individuals of diverse backgrounds in the United States. *JAMA* 2012;308:1775–84.
 19. Alsheikh-Ali AA, Omar MI, Raal FJ, et al. Cardiovascular risk factor burden in Africa and the Middle East: the Africa Middle East Cardiovascular Epidemiological (ACE) study. *PLoS ONE* 2014;9:e102830.
 20. Alkerwi A, Sauvageot N, Couffignal S, Albert A, Lair ML, Guillaume M. Comparison of participants and non-participants to the ORISCAV-LUX population-based study on cardiovascular risk factors in Luxembourg. *BMC Med Res Methodol* 2010;10:80.
 21. Crocker J, Lee-Lewandrowski E, Lewandrowski N, Baron J, Gregory K, Lewandrowski K. Implementation of point-of-care testing in an ambulatory practice of an academic medical center. *Am J Clin Pathol* 2014;142:640–6.
 22. Lee-Lewandrowski E, Lewandrowski K. Implementing point-of-care testing to improve outcomes. *J Hosp Adm* 2013;2:125–32.
 23. Yoong SL, Carey ML, Sanson-Fisher RW, et al. Touch screen computer health assessment in Australian general practice patients: a cross-sectional study protocol. *BMJ Open* 2012;2. pii: e001405.
 24. Health Action by People. Saantwanam project. Available at: <http://www.hapindia.org/html/saantwanam.html>. Accessed March 5, 2014.
 25. Braunack-Mayer A, Avery JC. Before the consultation: why people do (or do not) go to the doctor. *Br J Gen Pract* 2009;59:478–9.
 26. National Bureau of Statistics UAE. Population Estimates 2006–2010. Available at: <http://www.uaestatistics.gov.ae/EnglishHome/tabid/96/Default.aspx>; 2011. Accessed April 30, 2014.
 27. Wensil A, Smith J, Pound M, Herring C. Comparing point-of-care A1C and random plasma glucose for screening diabetes in migrant farm workers. *J Am Pharm Assoc* 2013;53:261–6.
 28. Health Quality Ontario. Point-of-care hemoglobin A1c testing: an evidence-based analysis. *Ont Health Technol Assess Ser* [Internet] 2014;14:1-30. Available at: <http://www.hqontario.ca/evidence/publications-andohtac-recommendations/ontario-health-technology-assessment-series/eba-point-of-care-a1c>. Accessed July 23, 2015.