Methods for establishing a surveillance system for cardiovascular diseases in Indian industrial populations

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Objective To establish a surveillance network for cardiovascular diseases (CVD) risk factors in industrial settings and estimate the risk factor burden using standardized tools.

Methods We conducted a baseline cross-sectional survey (as part of a CVD surveillance programme) of industrial populations from 10 companies across India, situated in close proximity to medical colleges that served as study centres. The study subjects were employees (selected by age and sex stratified random sampling) and their family members. Information on behavioural, clinical and biochemical determinants was obtained through standardized methods (questionnaires, clinical measurements and biochemical analysis). Data collation and analyses were done at the national coordinating centre.

Findings We report the prevalence of CVD risk factors among individuals aged 20–69 years (n = 19 973 for the questionnaire survey, n = 10 442 for biochemical investigations); mean age was 40 years. The overall prevalence of most risk factors was high, with 50.9% of men and 51.9% of women being overweight, central obesity was observed among 30.9% of men and 32.8% of women, and 40.2% of men and 14.9% of women reported current tobacco use. Self-reported prevalence of diabetes (5.3%) and hypertension (10.9%) was lower than when measured clinically and biochemically (10.1% and 27.7%, respectively). There was marked heterogeneity in the prevalence of risk factors among the study centres.

Conclusion There is a high burden of CVD risk factors among industrial populations across India. The surveillance system can be used as a model for replication in India as well as other developing countries.

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Introduction

Cardiovascular diseases (CVDs are major contributors to the global burden of chronic diseases with 29.3% of global deaths and 9.9% of total disease burden, in terms of disability-adjusted life years (DALYs) lost, being reported in 2003.[1] Low- and middle-income countries accounted for 78% and 86% of the CVD deaths and DALYs lost, respectively, worldwide in 1998.[2] Recent estimates by WHO suggest that in 2005, 80% of chronic disease deaths occurred in low- and middle-income countries.[3] This burden of CVD is predicted to increase substantially in developing countries by year 2020.[4] Major causes for the increase in disease burden are rising rates of hypertension, dyslipidaemia, diabetes, overweight, obesity, physical inactivity and tobacco use.[5]

In India, CVD is projected to be the largest cause of death and disability by 2020,[5] with 2.6 million Indians predicted to die due to coronary heart disease, which constitutes 54.1% of all CVD deaths. Nearly half of these deaths are likely to occur among young and middle-aged individuals (30–69 years). This is because Indians experience CVD deaths at least a decade earlier than their counterparts in developed countries.[6] This has the potential to adversely affect India's economy with 52% of CVD deaths occurring in those below the age of 70 years compared to 23% in countries in established market economies.[4]

Demographic and health transitions, gene-environmental interactions and early life influences of fetal malnutrition have been implicated as the causes of increasing CVD burden in India.[7] However, the most important factors are changes in living habits, whereby behavioural risk factors are transformed into biological risk factors. Such environmentally-determined risk factors are more amenable to change through

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public health and clinical interventions and, therefore, warrant early recognition at the individual level and surveillance at the population level.

To formulate national policies for the prevention and control of CVDs, nationally representative data collected through standardized techniques would be required. However, published cross-sectional studies on risk factors, such as hypertension,[8–11] diabetes,[11–14] impaired fasting glucose,[14] dyslipidaemia,[15] overweight,[16–19] obesity,[18,20] and smoking,[21–23] are highly heterogeneous and limited by variations in measurement techniques, interviewer bias, and differing definitions for risk factors and time periods of survey. We designed and established a sentinel surveillance system for CVD risk factors in Indian industrial populations with the following objectives:

- to conduct a baseline survey and continual surveillance of CVD risk factors and their determinants;
- to ascertain the incidence of CVD morbidity and mortality;
- to impart health education for prevention of CVD and assess the impact of health education on control of CVD;
- to develop guidelines for detection and management of CVD in the industrial settings, using the results of the baseline study.

We report the methods and results of the baseline survey conducted in 2002–03, in accordance with the first objective.

Methods

Study setting

We selected 10 medium-to-large companies (employing 1500–5000 people) in the organized sector (both public and private), from different sites across India, based on their willingness to participate in the study and proximity to an academic medical institution. Ten medical colleges designated as study centres were linked to each of these selected companies (Table 1, web version only, available from: http://www.who.int/bulletin). The study team included faculty members from various departments (medicine, cardiology, preventive medicine, and biochemistry) of each medical college headed by a principal investigator and supported by a biochemical investigator from the medical college as well as an industrial medical officer who represented the company. A research team comprising medical and non-medical staff assisted the study team.

Sampling

All employees and their family members, age 10–69 years, from each participating centre were eligible for inclusion in the study. At each participating centre, detailed data were obtained from 800 randomly selected employees and their eligible family members. We expected a total of 2400 individuals from each centre to participate in this study with at least 200 individuals in each decile starting from 10–19 years to 60–69 years. Since, we did not collect blood samples from the 10–19 years age-group (for ethical reasons), their data are not included in this report. Of the remaining 2000 we chose 1000 individuals per centre, aged 20–69 years, by stratified random sub-sampling for adequate representation of all age deciles and sex groups. When required we used purposive over-sampling to include additional eligible participants to attain the required cell size. We expected to include 20 000 individuals to generate demographic and clinical data and 10 000 for biochemical data. At the Delhi centre, in accordance with the stipulation of the management of the participating industry, we surveyed all the employees and family members based on the prespecified randomization sequence, while at the Ludhiana centre we did not survey family members.

Study variables

We collected data on demographics, individual characteristics associated with major risk factors of CVD, past medical history, clinical and anthropometric profile and biochemical parameters (Table 2).

Quality control measures

To ensure the accuracy, completeness, as well as comparability of blood pressure, anthropometric measurements, and interviewee responses across the

Table 2. **Study variables for the baseline survey of cardiovascular risk factors in 10 industrial populations, India, 2002–03**

Determinants		
Socioeconomic	**Demographic**	**Behavioural**
Education[a]	Age	Tobacco consumption
Occupation[b]	Gender	Alcohol consumption
Income	Urban/rural residence	Diet
Marital status		Physical exercise/activity[c]
		Stress
Risk factors		
Clinical examination	**Questionnaire**	**Biochemical tests**
Pulse rate	History of CVD,[d] hypertension[e] and diabetes[f]	Fasting blood glucose
Systolic blood pressure		Total cholesterol
Diastolic blood pressure	Family history of hypertension, diabetes and CVD	HDL[g] cholesterol
Weight		Triglyceride
Height	Smoking	
Waist circumference		

[a] The highest educational level and included six groups — professional, postgraduate, graduate, secondary school, up to primary/literate and illiterate.
[b] The current primary occupation was the employment status of the individual.
[c] Physical activity level assessed using close-ended questions probing the self-perceived, self-reported type (occupational, domestic, leisure time and transport related) and intensity of physical activity, was classified as "very light" (walking, job involving desk work, watching television), "light" (standing all day working, housework such as cooking, cleaning in the house), "moderate physical activity" (gardening, agricultural work, walking long distances up and down hills, climbing more than 20 steps in a day), and "heavy" (lifting heavy weights, construction work, manual labour, and running).
[d] CVD = cardiovascular disease.
[e] Either a systolic blood pressure ⩾140 mmHg, and/or a diastolic blood pressure ⩾90 mmHg, and/or on drug treatment for hypertension.[24]
[f] Either fasting blood glucose value ⩾126 mg/dl[25] and/or on medication for diabetes. Impaired fasting glucose (IFG) was a fasting blood glucose value ⩾110 to <126 mg/dl.
[g] HDL = high density lipoprotein.

10 centres, we included several quality control measures in the study protocol. We developed a common manual of operations and distributed it to all participating centres. To ensure uniformity of data collection we conducted national-level questionnaire administration training sessions for all study staff. We pilot-tested all questions for clarity and "face validity" ("Does the question refer to what it intends to seek?") and developed the standard final version of the questionnaire and distributed to all centres.

Pilot study

We conducted a pilot study using 10–25 individuals in May–June 2001, in all the centres, to evaluate the measurement tools, feasibility of transporting blood samples for biochemical analysis, efficiency of data transfer and quality assessment of transferred data. We modified the study protocol and survey instruments based on results from the pilot study. Those who were part of the pilot study were excluded from the main study.

Questionnaire administration and measurement techniques

We obtained written informed consent from the 19 973 individuals who responded to the questionnaire survey. We estimated fasting blood glucose and fasting lipid profile in 10 442 individuals. Blood was collected after an overnight fast of 10–12 hours. Blood pressure (BP) was measured using automated BP monitoring equipment (Omron MX3) according to the procedure detailed in the instruction manual. Waist circumference (WC) was measured with a standard tape measure, while subjects were lightly clothed, at a level midway between the lower rib margin and iliac crest in centimetres (cm) to the nearest 0.1 cm. Weight was taken (to the nearest 0.1 kg) with the subject standing motionless on an electronic weighing machine without shoes or any heavy outer garments, and weight equally distributed over each leg. Height was measured (to the nearest 0.1 cm) using a standard stadiometer with the subject standing erect against a vertical surface, without shoes, and the head positioned such that top of the external auditory meatus was level with the inferior margin of the bony orbit.

Laboratory techniques and biochemical standardization

The Department of Cardiac Biochemistry at the All India Institute of Medical Sciences (AIIMS), New Delhi was responsible for biochemical standardization at each centre and coordination. We estimated glucose by GOD-PAP (glucose oxidase/peroxidase-4-aminophenazone-phenol; Randox) method, cholesterol by CHOD-PAP (cholesterol oxidase/p-aminophenazone; Randox) method, and triglycerides by GPO-PAP (glycerolphosphate oxidase–peroxidase aminophenazone; Randox) method. High-density lipoprotein (HDL) was estimated by the precipitation method using phosphotungstate/magnesium — precipitation of apolipoprotein B containing lipoproteins followed by estimation of cholesterol in the supernatant by enzymatic method. All estimation kits and quality control materials were sent from the coordinating laboratory to the centre to minimize variation.

We regularly performed both internal and external quality assessments at all participating laboratories along with validity checks to ensure accurate and consistent results. For quality assurance, we conducted different levels of internal quality controls with each batch of samples. The inter- and intra-assay coefficient of variation of each individual laboratory was less than 2% and 3%, respectively, for glucose and cholesterol estimations, and less than 2.5% and 3.5%, respectively, for triglycerides and HDL-cholesterol (HDL-c) estimations. For external validation, we sent lyophilized samples from the coordinating laboratory once a month to all participating laboratories throughout the period of the study. We also re-analysed 10% of samples selected randomly from all centres in the coordinating laboratory as an additional quality assurance measure. The coefficient of variation was less than 5% for all, except for HDL-c at Bangalore (this was re-analysed at the coordinating centre).

Table 3. **Distribution of the study population across 10 sites in the baseline survey, India, 2002–03**

Sites	Men (*n*)	Women (*n*)	Total (*n*)
Bangalore	53.4 (906)	46.6 (790)	100% (1696)
Coimbatore	52.7 (1100)	47.3 (989)	100% (2089)
Delhi	69.3 (2354)	30.7 (1043)	100% (3397)
Dibrugarh	49.5 (1190)	50.5 (1213)	100% (2403)
Hyderabad	68.4 (882)	31.6 (407)	100% (1289)
Lucknow	55.6 (944)	44.4 (755)	100% (1699)
Ludhiana	97.9 (832)	2.1 (18)	100% (850)
Nagpur	63.2 (1408)	36.8 (819)	100% (2227)
Pune	50.4 (1164)	49.6 (1144)	100% (2308)
Trivandrum	55.5 (1118)	44.5 (897)	100% (2015)

Findings

Based on our proposed sampling scheme we approached 22 266 individuals. However, only 19 973 consented to participate in the study, yielding a response rate of 89.7%. The response rates varied across centres. The distribution of the study population is provided in Table 3. The general characteristics of the study population are given in Table 4 (web version only, available from: http://www.who.int/bulletin).

Demographic characteristics

The mean age of the participants in our study was 40 years (range of mean age: 32 years at Nagpur to 45.4 years at Delhi), with only 5% in ⩾60 age group. More than three-quarters of the subjects (77.7%) had at least secondary school education while 12.1% were illiterate. A third (34%) of the study population comprised both unemployed or retired individuals (10%) and home-makers (24%). We observed a wide variation in educational status and occupation across all centres.

Behavioural determinants

Our results showed that one-third (33.6%) of the subjects had history of tobacco use in any form and 30% were using tobacco regularly. Smoking was the major form of tobacco use (12.6%), followed by use as snuff (10.7%), and tobacco chewing (9%). Current smoking and chewing prevalence rates were signif-

Table 5. **Age-specific blood pressure, body mass index, waist circumference and lipid levels (mean ± SD) in 10 industrial populations, India, 2002–03**

Variable	20–29 years		30–39 years		40–49 years		50–59 years		⩾ 60 years		Total	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Systolic blood pressure (mmHg)	121.9 ± 11.8	114.2 ± 11.4	123.4 ± 12.3	119.1 ± 13.9	127.8 ± 6.5	126.1 ± 16.6	132.8 ± 19.1	133.9 ± 19.8	137.9 ± 20.8	142.0 ± 20.6	127.0 ± 16.2	123.1 ± 17.5
Diastolic blood pressure (mmHg)	75.3 ± 9.9	73.21 ± 9.6	78.6 ± 9.9	77.2 ± 10.5	80.8 ± 11.0	80.4 ± 10.5	81.8 ± 10.8	82.8 ± 10.7	80.7 ± 11.6	82.7 ± 9.7	79.24 ± 10.8	78.1 ± 10.8
Body mass index (kg/m²)	21.24 ± 3.4	21.2 ± 3.8	22.8 ± 3.7	23.5 ± 4.7	24.0 ± 3.7	25.2 ± 4.7	24.1 ± 3.7	24.1 ± 5.2	20.9 ± 3.9	21.4 ± 5.2	23.0 ± 3.8	23.3 ± 4.9
Waist circumference (cm)	78.65 ± 9.1	74.5 ± 10.3	84.2 ± 9.9	80.1 ± 11.4	88.2 ± 9.9	83.7 ± 11.5	89.2 ± 10.0	82.3 ± 12.3	80.4 ± 11.2	78.0 ± 13.0	85.0 ± 10.6	79.8 ± 11.9
Triglycerides (mg/dl)	158.5 ± 36.6	159.7 ± 34.9	170.5 ± 39.9	168.6 ± 35.6	185.9 ± 39.2	185.9 ± 39.9	183.9 ± 38.8	189.5 ± 44.4	165.6 ± 41.1	182.1 ± 46.1	177.1 ± 40.2	175.7 ± 40.1
High density lipoprotein cholesterol (mg/dl)	40.9 ± 9.7	45.1 ± 11.1	41.9 ± 10.6	44.4 ± 10.9	41.1 ± 9.6	44.3 ± 10.8	41.8 ± 10.4	44.7 ± 11.0	43.2 ± 11.1	45.5 ± 12.0	41.5 ± 10.1	44.6 ± 10.9
Triglycerides (mg/dl)	112.9 ± 65.2	95.1 ± 47.0	137.6 ± 81.3	107.7 ± 55.2	148.6 ± 82.4	124.4 ± 65.8	141.2 ± 77.0	129.7 ± 74.5	114.5 ± 66.5	124.4 ± 57.9	137.4 ± 78.6	114.1 ± 61.6

icantly higher among men (21% versus 0.2% and 13.3% versus 2.6%) whereas tobacco use as snuff was higher among women (9.5% versus 12.4%). Of our study subjects 12% took alcohol regularly and 12.5% took alcohol occasionally. A large number of our study participants (51.4%) reported medium level of physical activity, 3.4% reported very light physical activity, while 13% reported high physical activity level.

Anthropometric measurements

Our results showed a mean body mass index (BMI) of 23.1 kg/m² (95% confidence interval (95% CI) = 14.8–31.4 kg/m²). The overall prevalence of overweight (BMI ⩾23 kg/m²) was 51.3% (50.9% in men and 51.9% in women), however, the prevalence of overweight based on the WHO definition (BMI ⩾25 kg/m²) was 30.9%. The mean WC was 82.9 cm (95% CI = 60.6–105.2 cm); significantly higher among men (85.0 cm) than women (79.9 cm). Central obesity was 18.2% among men (WC >94 cm) and 23.3% among women (WC >88 cm). Using modified waist circumference cut-offs appropriate for Indian populations (WC >90 cm for men and WC >85 cm for women), the prevalence of central obesity was 30.9% and 32.8% among men and women, respectively.[20] Women had a higher prevalence of central obesity compared to men, across all age groups. The age- and sex-specific mean levels of BP, BMI, WC, and lipid levels as continuous variables are given in Table 5 and the age- and sex-specific prevalence of elevated risk factors as categorical variables are provided in Table 6.

Clinical and biochemical measurements

Blood pressure

Mean systolic blood pressure (SBP) was 125.4 mmHg (127.0 mmHg in men, 123.1 mmHg in women) and mean diastolic blood pressure (DBP) was 78.8 mmHg (79.2 mmHg in men, 78.1 mmHg in women). Both mean SBP and DBP increased with age among men and women. The SBP levels among men were significantly higher than those among age-matched women until the age of 49 years, after which the levels were higher among women. Self-reported prevalence of hypertension was 10.9% and the prevalence of hypertension and "pre-hypertension" ("Blood pressure between 120/80 mmHg and 139/89 mmHg."), by JNC VII criteria was 27.7%, and 56.3%, respectively. The prevalence of hypertension and pre-hypertension increased with age.

Lipids

Mean total cholesterol and mean HDL cholesterol were 176.6 mg/dl (177.1 mg/dl in men, 175.7 mg/dl in women) and 42.3 mg/dl (41.5 mg/dl in men, 44.6 mg/dl in women), respectively. Mean total cholesterol increased with age, whereas HDL cholesterol had no linear relationship with age. The mean total cholesterol–HDL cholesterol ratio (TC/HDL-c) was 4.3 (4.4 in men, 4.1 in women). Women had lower TC/HDL-c compared to men across all age groups. Dyslipidaemia prevalence (TC/HDL ⩾4.5 or triglycerides ⩾150 mg/dl) showed a linear increase with age, until the age of 50 years. Dyslipidaemia in the age group 50–59 years (for both men and women) did not differ from that in the previous age group; however, it was lower in the age group of 60–69 years, than in the previous age groups.

Diabetes and metabolic syndrome

Self-reported diabetes prevalence was 5.3%, while that of diabetes and impaired fasting glucose (IFG) by WHO criteria were 10.1% and 6.4%, respectively. Metabolic syndrome prevalence was 26.6% (20.9% in men, 36.3% in women) by modified NCEP ATP III criteria[26] and 35.4% (29.4% in men, 46.1% in women) by the recently proposed IDF criteria for south Asians.[27]

Age-adjusted prevalence of risk factors

The age-adjusted prevalence of major risk factors of CVD using 2001 Indian census data was 26% for hypertension, 8.4% for diabetes, 24.8% for metabolic

Table 6. **Prevalence of overweight, central obesity, dyslipidaemia, diabetes, hypertension and metabolic syndrome across various age groups in 10 industrial populations, India, 2002–03**

Variable	20–29 years		30–39 years		40–49 years		50–59 years		⩾ 60 years		Total	
	Men (*n*)	Women (*n*)	Men (*n*)	Women (*n*)	Men (*n*)	Women (*n*)	Men (*n*)	Women (*n*)	Men (*n*)	Women (*n*)	Men (*n*)	Women (*n*)
BMI[a] ⩾23 kg/m²	30.1 (836)	29.1 (641)	48.8 (1250)	52.9 (1059)	62.0 (2114)	70.6 (1609)	64.2 (1664)	61.9 (647)	31.1 (152)	42.3 (210)	50.9 (6016)	51.9 (4166)
BMI ⩾25 kg/m²	12.2 (338)	13.9 (306)	26.1 (669)	35.0 (702)	37.4 (1276)	52.1 (1187)	39.7 (1029)	41.9 (438)	13.8 (67)	24.6 (122)	28.6 (3379)	34.3 (2755)
Central obesity[b]	8.8 (243)	14.6 (316)	25.3 (648)	32.0 (640)	42.3 (1443)	45.7 (1041)	47.6 (1233)	44.6 (467)	18.4 (90)	31.5 (156)	30.9 (3657)	32.8 (2620)
TC/HDL[c] ⩾4.5	32.0 (365)	21.3 (184)	38.2 (449)	31.9 (321)	52.8 (1195)	44.1 (598)	51.5 (889)	47.2 (224)	31.3 (52)	45.4 (59)	45.6 (2950)	36.2 (1386)
Triglycerides ⩾150 mg/dl	19.1 (222)	10.3 (91)	33.0 (393)	16.7 (170)	37.6 (856)	26.2 (360)	34.3 (595)	26.0 (127)	21.3 (36)	25.0 (33)	32.2 (2102)	20.1 (781)
Diabetes[d]	0.9 (10)	0.9 (8)	4.4 (53)	4.2 (43)	12.4 (282)	10.8 (149)	20.7 (360)	17.0 (83)	16.0 (27)	27.3 (36)	11.2 (732)	8.2 (319)
Hypertension[e]	12.2 (337)	5.9 (129)	19.3 (494)	17.1 (342)	34.6 (1180)	31.4 (715)	46.9 (1215)	50.9 (532)	49.2 (240)	62.0 (308)	29.3 (3466)	25.2 (2026)
Metabolic syndrome[f]	10.2 (117)	12.9 (111)	13.1 (154)	33.7 (339)	21.7 (491)	45.2 (613)	30.8 (532)	52.0 (247)	35.5 (59)	61.5 (80)	20.9 (1353)	36.3 (1390)

[a] BMI = body mass index.
[b] Waist circumference >90 cm in males; >85 cm in females.
[c] TC/HDL = total cholesterol to HDL cholesterol ratio.
[d] Fasting plasma glucose ⩾126 mg/dl or drug treatment for diabetes mellitus.
[e] Systolic blood pressure ⩾140 mmHg or diastolic blood pressure ⩾90 mmHg or under medication for hypertension.
[f] Based on NCEP ATP III criteria.[26] NCEP ATP III guidelines define metabolic syndrome based on presence of any three of the following five components: abdominal obesity, elevated triglycerides, low HDL cholesterol, raised blood pressure and impaired fasting glucose levels.

syndrome, 46.7% for BMI ⩾23 kg/m², 25.5% among men and 30.3% among women for central obesity (WC >90 cm in men, WC >85 cm in women), 37.5% for dyslipidaemia (TC/HDL ⩾4.5) and 24.3% for hyper-triglyceridaemia (triglycerides ⩾150 mg/dl) (Fig. 1).

Heterogeneity in risk factors among participating centres

Our results showed wide-ranging heterogeneity among risk factor prevalence across the different centres (Table 7, web version only, available from: http://www.who.int/bulletin). Current tobacco use was highest in Dibrugarh (83.8%) and lowest in Bangalore (15.4%). Current tobacco use was very low among women compared to men across all centres (14.9% in women versus 40.2% in men). However, in Dibrugarh the prevalence of current tobacco use among women was exceptionally high (77.8%). Prevalence of hypertension was high in Hyderabad (39.1%) and Lucknow (38.4%) and lowest in Nagpur (16.9%). Diabetes prevalence varied from 2.3% in Dibrugarh to 16.6% in Trivandrum. A relatively low prevalence of diabetes was reported in Nagpur (4.2%) and Coimbatore (7.7%). High prevalence of metabolic syndrome was seen in Bangalore (38.8%), Trivandrum (37.9%), Hyderabad (33.0%), Lucknow (29.0%), Coimbatore (28.2%) and Delhi (22.9%) centres. A comparatively low prevalence of metabolic syndrome was reported in Nagpur (17.8%) and Dibrugarh (19.9%).

Discussion

In the absence of a population-based nationally representative surveillance system for CVD, establishing a multicentric surveillance system in industrial settings could be a useful initial step, the first component being a baseline cross-sectional survey of risk factors.

In our baseline cross-sectional survey the choice of industrial settings was based on the availability of functioning health-care services in those industries and the assurance of good follow-up. The additional costs of CVD surveillance under such circumstances are low with high quality information yield. The inclusion of family members allowed us to study people in the age groups of 10–19 years and 60–69 years as well as a large number of women to balance the predominantly male employee group.

We observed a high prevalence of CVD risk factors among a relatively young population across the selected industrial populations. Our results are consistent with high prevalence of CVD risk factors reported in previous cross-sectional studies conducted at various geographical locations in India.[8–23] If we project our findings to the whole industrial population of India the magnitude of the number of persons living with CVD risk factors, such as tobacco use, overweight, hypertension, diabetes, and metabolic syndrome would pose a major challenge to the existing health-care systems.

Our results showed marked heterogeneity in the prevalence of risk factors across the centres. This may be due to dissimilar levels of urbanization in the different industrial settings as some are located in a rural/semi rural situation while others are in more urbanized regions. For example, the prevalence of diabetes was low in the predominantly rural setting of Dibrugarh and Nagpur.

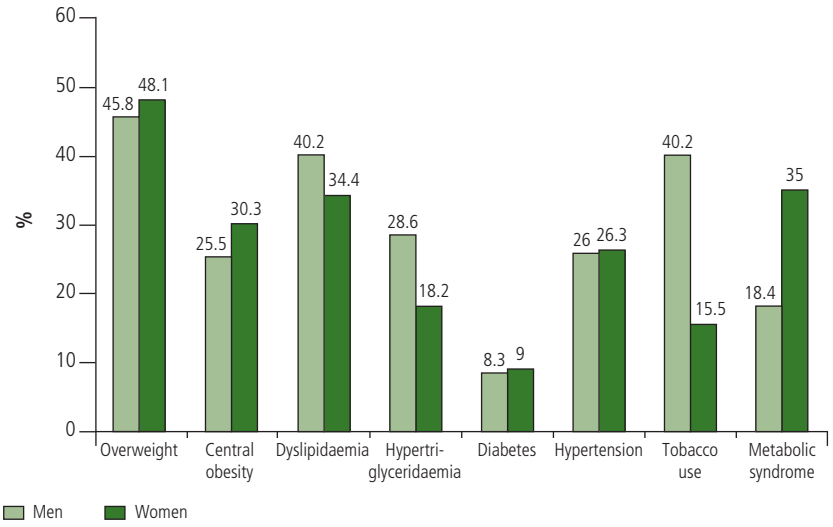
The only exception was the high prevalence of hypertension among the tea garden workers of Dibrugarh, which could be attributable to the practice by employees of adding salt to drinking water and tea while working in the field.

Wide variability in the measurements of lipids, specifically triglycerides and HDL-c, are well known and standardizing these measurements is particularly difficult.[30] Our biochemical quality control strategies were a unique feature of this study. Through simple measures of maintaining internal validity of the participating laboratories and ensuring external validity by assessment of blinded lyophilized samples we were able to establish a high degree of quality in the 10 participating laboratories.

One of the limitations of our study was the industrial setting, which may not be representative and applicable to the general population. The participants in our sentinel surveillance system formed a stable surrogate community for surveillance unlike the general population where loss to follow-up is frequent and continuous monitoring of risk factors more expensive. Though the inclusion of family members of employees in the reference population should have improved the generalization of the results, the age structure and socioeconomic status of the industrial populations are different from that of the general population. The results of our study cannot be generalized to those ⩾60 years of age, as the numbers in this age group, especially women, were small in our sample compared to other age groups. Further, the sustainability of the system depends on the continuing interest of the participating companies.

The high levels of risk observed with our baseline cross-sectional survey justifies the need for establishing a surveillance system to monitor the trends of CVD risk factors over time and has persuaded the participating industries to accept the proposed system of periodic re-surveys of CVD risk factors as well as of continual tracking of CVD-related events. It also enabled us to initiate worksite programmes for health promotion and CVD reduction. We are continuing surveillance activities in seven of the 10 selected industrial settings, which includes physical and biochemical measures of major risk factors, periodic estimates of validity of the data collected and a broader set of outcome indicators beyond risk factor prevalence. A health education intervention package that was developed is being implemented in all industrial settings, and would help the target community to change risky behaviours to healthy behaviours. It would also enable us to demonstrate the effectiveness of the health intervention package in terms of change in knowledge, attitude and risk factor prevalence levels in the target community. In an effort to assess the trends in CVD mortality and morbidity an event registry, initiated at all selected industrial centres successfully from May 2003, would help us estimate the incidence of CVD mortality and morbidity in the selected populations.

Fig. 1. **Age-adjusted prevalence of cardiovascular disease risk factors in 10 industrial centres, India, 2002–03**



Overweight = body mass index (BMI) ‡23 kg/m^2, which is the suggested cut-off for Asians.[28, 29]
Central obesity = waist circumference >90 cm in males; >85 cm in females.
Dyslipidaemia = total cholesterol/HDL-cholesterol ratio.
Hypertriglyceridemia = fasting triglyceride level ‡150 mg/dl.
Diabetes = fasting plasma glucose ‡126 mg/dl or on treatment.
Hypertension = systolic blood pressure ‡140 mmHg or diastolic blood pressure ‡90 mmHg or on treatment.
Tobacco use = current use of tobacco in any form.
Metabolic syndrome, based on NCEP ATP III criteria.[26]

WHO 06.74

Conclusions

Our study has demonstrated very high levels of CVD risk factors among a relatively young population from 10 industrial settings across India. The surveillance network established by this project is the first of its kind for CVD risk factors in India and can be used as a model for replication of prevention strategies for CVD and other noncommunicable diseases in India as well as other developing countries. The dissemination of these findings may encourage other companies to set up surveillance activities especially in developing countries where the organized work force comprises a substantial number of individuals. Continuing surveillance efforts would provide us with an opportunity to develop evidence-based cost-effective CVD prevention, detection and management strategies. ■

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Résumé

Méthodes pour mettre en place un réseau de surveillance des maladies cardiovasculaires chez les employés d'entreprises industrielles indiennes et leurs familles

Objectif Mettre en place un système de surveillance des facteurs de risques de maladie cardiovasculaire (MCV) sur des sites industriels et estimer au moyen d'outils standardisés la charge de facteurs de risque.

Méthodes Une étude transversale de référence a été menée (dans le cadre d'un programme de surveillance des MCV) parmi les employés de 10 entreprises industrielles et leurs familles, ces entreprises étant situées dans différentes régions de l'Inde et à proximité de facultés de médecine qui ont servi de centres d'étude. Les sujets de l'étude ont été sélectionnés parmi les employés et leurs familles (échantillon aléatoire stratifié selon l'âge et le sexe). Des informations relatives aux déterminants comportementaux, cliniques et biochimiques ont été obtenues par des méthodes standardisées (questionnaires, mesures cliniques et analyse biochimique). La collecte des données et les analyses ont été effectuées par le centre coordinateur national.

Résultats L'article indique la prévalence des facteurs de risque de MCV parmi des sujets de 20 à 69 ans (n = 19 973 pour l'enquête par questionnaire, n = 10 442 pour les études biochimiques), dont l'âge moyen était de 40 ans. Il relève une forte prévalence globale de la plupart des facteurs de risque : 50,9 % des hommes et 51,9 % des femmes présentent une surcharge pondérale, 30,9 % des hommes et 32,8 % des femmes souffrent d'une obésité centrale, 40,2 % des hommes et 14,9 % des femmes signalent qu'ils ou elles fument actuellement du tabac. Les prévalences autorapportées du diabète (5,3 %) et de l'hypertension (10,9 %) sont plus faibles que celles mesurées par des examens cliniques et biochimiques (10,1 % et 27,7 % respectivement). On constate une hétérogénéité marquée de la prévalence des facteurs de risque entre les centres d'étude.

Conclusion La charge de facteurs de risque de MCV relevée chez les employés d'entreprises industrielles réparties à travers l'Inde et leurs familles est élevée. Le système de surveillance établi peut être utilisé comme modèle pour être transposé à d'autres populations Indiennes et à d'autres pays en développement.

Resumen

Métodos para establecer un sistema de vigilancia de las enfermedades cardiovasculares en poblaciones industriales de la India

Objetivo Establecer una red de vigilancia de los factores de riesgo de enfermedades cardiovasculares (ECV) en entornos industriales y estimar la carga de factores de riesgo utilizando instrumentos normalizados.

Métodos Llevamos a cabo una encuesta transversal basal (como parte de un programa de vigilancia de las ECV) de las poblaciones industriales de 10 empresas de la India, situadas muy cerca de las escuelas de medicina empleadas como centros de estudio. Los sujetos estudiados eran empleados de esas empresas (seleccionados mediante muestreo aleatorio estratificado por edad y sexo) y sus familiares, y la información referente a los determinantes comportamentales, clínicos y bioquímicos se obtuvo mediante métodos normalizados (cuestionarios, variables clínicas y análisis bioquímicos). La recopilación y el análisis de los datos se hicieron en el centro coordinador nacional.

Resultados Notificamos aquí la prevalencia de los factores de riesgo de ECV entre los individuos de 20 a 69 años (n = 19 973 para la encuesta mediante cuestionario, n = 10 442 para los análisis bioquímicos), con una edad media de 40 años. La prevalencia general de la mayoría de los factores de riesgo fue alta: exceso de peso en el 50,9% de los hombres y el 51,9% de las mujeres, obesidad central en el 30,9% de los hombres y el 32,8% de las mujeres, y consumo de tabaco en el 40,2% de los hombres y el 14,9% de las mujeres. La prevalencia autonotificada de diabetes (5,3%) e hipertensión (10,9%) fue menor que la determinada clínica y bioquímicamente (10,1% y 27,7%, respectivamente). Se observó una notable heterogeneidad en la prevalencia de factores de riesgo entre los centros de estudio.

Conclusión Existe una alta carga de factores de riesgo de ECV entre las poblaciones industriales en la India. El sistema de vigilancia puede servir de modelo para repetir la experiencia en este país y en otros países en desarrollo.

ملخص

طرق إنشاء نظام لترصُّد الأمراض القلبية الوعائية بين المجموعات السكانية الهندية في المواقع الصناعية

الهدف: تأسيس شبكة لترصُّد عوامل خطر الأمراض القلبية الوعائية في المواقع الصناعية وتقدير عبء عوامل الخطر باستعمال أدوات معيارية.

الطريقة: أجرينا مسحاً أساسياً شاملاً للقطاعات (كجزء من برنامج ترصُّد الأمراض القلبية الوعائية) في المجموعات السكانية في المواقع الصناعية لعشرة شركات في مختلف أرجاء الهند تقع قريباً من كليات الطب التي كانت بمثابة مراكز الدراسة. وكان عناصر الدراسة هم الموظفون (وتم اختيارهم وفق عينات عشوائية ذات طبقات وفقاً للعمر وللجنس)، وأفراد أسرهم، ومعلومات حول المحدِّدات السلوكية والسريرية (الإكلينيكية) والكيميائية الحيوية تم الحصول عليها بطرق معيارية (الاستبيانات والإجراءات السريرية (أو الإكلينيكية) والتحليلات الكيميائية الحيوية). وقد أجري تجميع المعطيات وتحليلها في مركز وطني للتنسيق.

الموجودات: أبلغنا في تقريرنا عن معدل انتشار عوامل خطر الأمراض القلبية الوعائية بين الشباب الذين تتراوح أعمارهم بين 20 – 69 عاماً (وعددهم 19 973 ممن استكملوا الاستبيان، وعددهم 10 442 ممن خضعوا للاستقصاءات الكيميائية الحيوية)، وكان متوسط العمر 40 عاماً، وبلغ المعدل الإجمالي لانتشار معظم عوامل الخطر مستوى مرتفعاً، فكان بالنسبة للبدانة 50.9% لدى الرجال و51.9% لدى النساء، وللبدانة المركزية 30.9% لدى الرجال و32.8% لدى النساء، ولتعاطي التبغ 40.2% لدى الرجال و14.9% لدى النساء. فيما بلغ معدل انتشار الإبلاغ الذاتي عن السكري 5.3% وعن ارتفاع ضغط الدم 10.9% وكان هذا أقل من معدل القياسات السريرية (الإكلينيكية) والكيميائية الحيوية التي بلغت 10.1% بالنسبة للسكري و27.7% بالنسبة لارتفاع ضغط الدم. وكان هناك قدر كبير من عدم التجانس في انتشار عوامل الخطر بين مراكز الدراسة.

الاستنتاج: كان هناك عبء مرتفع لعوامل خطر الأمراض القلبية الوعائية بين المجموعات السكانية في المواقع الصناعية في جميع أرجاء الهند، ويمكن استخدام برنامج الرصد كنموذج لتكثير المعطيات في الهند، وفي البلدان النامية الأخرى.

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