Lifestyle-related risk factors for cardiovascular disease in a desert population of India

Kripa Ram Haldiya*, Murli L. Mathur and Raman Sachdev

Desert Medicine Research Centre, Pali Road, Jodhpur 342 005, India

Population aged 20 years and above of three selected villages of Rajasthan was studied (n = 1825) to assess prevalence of lifestyle-related risk factors for cardiovascular diseases (CVD). BMI > 24.99 was found in 13.4%, proportion of females with abdominal obesity (WHR > 0.8) was 62.6%, which was significantly higher (p < 0.00001) than of males (51.2% with WHR > 0.9); 58.3% males and 7.1% females used tobacco. Average salt consumption was 8.3 ± 3.3 g/day. It was more than 5 g/day in 88.0% subjects and was more than 10 g/day in 21.6%. Average oil + ghee consumption was 32.3 ± 14.9 g/day and 40.0% had sedentary lifestyle. Prevalence of hypertension was 23.1%. Results underline the need for increasing community awareness about behavioural risk factors for CVD in rural areas.

Keywords: Blood pressure, cardiovascular diseases, hypertension, lifestyle, risk factors.

CARDIOVASCULAR disease (CVD), including coronary heart disease (CHD) and stroke, is rapidly emerging as an important cause of mortality and morbidity in developing countries, though in developed countries cardiovascular mortality declined in the second half of 20th century[1]. Several behavioural risk factors like obesity, sedentary lifestyle, tobacco use, high salt intake, alcohol use and excessive dietary fats are associated with the development of CVD and also vary geographically. The parameters measured using invasive procedures also make an elaborate list of risk factors for CVD but strategies for preventing CVD include measures to control its major lifestyle-related risk factors at community level. Preventive activities can be initiated on the basis of lifestyle-related risk factors, if their prevalence is known. High prevalence of hypertension was reported in rural areas of Rajasthan[2]. The aim of the present study was to assess prevalence of lifestyle-related risk factors and their association with hypertension in the rural population of Rajasthan.

Materials and methods

A cross-sectional population-based study was carried out in rural population of three villages of Gachipura Gram Panchayat (District Nagaur, Rajasthan), viz. Itwa Bamnia, Itwa Lakha and Itwa Khichiyan from where high prevalence of hypertension was reported. Entire population of these villages was included in the study. Door-to-door survey of all houses in these villages was carried out by a team consisting of a physician (K.R.H.) and two field investigators. Field investigators were trained for measuring blood pressure and anthropometric measurements (height, weight, waist circumference and hip circumference). After obtaining informed consent, all available individuals of age 20 years and above were interviewed and information about their age in completed years, education, occupation, dietary salt consumption, tobacco use, alcohol consumption and pattern of daily physical activity was recorded in a pre-tested schedule. The dietary salt and oil/ghee consumption per month for the whole family was recorded. It was divided by 30 and total consumption units in the family which was then multiplied with consumption unit of the individual to get the individual's dietary intake per day. Age of the subjects was recorded as mentioned in school certificates and assessed using local calendar of events for illiterate people. The blood pressure of participants was measured in the supine position after 5 min of rest. An electronic sphygmomanometer (Omron T4 model) with adult or large size cuff was used. Three blood pressure measurements were taken with 5 min intervals. The third reading was taken for diagnosis of hypertension. Body weight was measured (to the nearest of 0.5 kg) with the participant in standing position on weighing scale, feet about 15 cm apart and equally distributing weight on both lower limbs with minimum clothes and no footwear. Height was measured using anthropometric rod with the subject in standing position and with the head positioned so that the top of the external auditory meatus was level with the inferior margin of the bony orbit. Waist circumference was measured in centimetres (cm) at the level of umbilicus to the nearest 0.1 cm. Hip circumference was measured at the trochenteric level in centimetres to the nearest 0.1 cm. Hypertension was defined as either systolic blood pressure above 139 mm Hg and/or a diastolic blood pressure above 89 mm Hg and/or treatment with anti-hypertensive medications[3]. Tobacco use included use of both smoking and smokeless tobacco. Physical activity of individual in his daily routine life was enquired.

*For correspondence. (e-mail: haldiyakr@rediffmail.com)

Sedentary work was defined as work continued for at least 10 min, in which one neither feels increase in breathing rate nor in heart rate while working[4]. Those who never felt increase in heart rate or respiratory rate after work, were considered as having sedentary lifestyle. Body mass index (BMI) was calculated by dividing weight in kilograms (kg) with square of height in metres. Obesity was defined as BMI = 25 or more as the World Health Organization has revised the BMI cut-off for Asian Indians and suggested a BMI of 25 kg/m^2 to define obesity against the 30 kg/m^2 recommended for Europeans[5]. Abdominal obesity was defined as waist hip ratio (WHR) exceeding 0.8 and 0.9 for women and men respectively[6]. Data were analysed using Epi 2002 software and Chi square test and Student's t test was used to study statistical significance of the differences observed.

Observations

There were 2911 subjects of age 20 years and above in all 922 households of the selected villages. All the required information could be collected from about 1825 (62.7%) of these 2911 individuals as others were either not available at the time of survey or were out of station. The information about age, sex, education, tobacco use, etc. of all absent members of the family was also obtained from the heads of households. The age-wise composition as well as educational status of members absent were not different from those available at the time of survey. The prevalence of tobacco use in males available for survey was not significantly different in males absent at the time of survey ($p = 0.15$). This indicates the characteristics of the covered population of 1825 were not different from those absent at the time of survey.

Mean BMI was 20.4 ± 3.4 kg/m^2 in males and 20.9 ± 4.0 kg/m^2 in females. It increased with age. BMI was 23 or higher in 24.1% and was 25 or higher in 13.4%, which was not different in males and females. There was a negligible number of people with higher grade of obesity.

Mean waist circumference was 70.9 ± 11.1 cm. It was 74.7 ± 11.3 cm in males and 68.9 ± 10.5 cm in females, which also increased with age. Proportion of males with truncal obesity (WHR > 0.9) was 51.2%, which was significantly lower ($p < 0.00001$) than that of females (62.6% with WHR > 0.8). Prevalence of tobacco consumption (smoking and chewing tobacco) was 58.3% in males and 7.1% in females. Among the tobacco users, males used oral tobacco and smoked as well whereas females mostly used oral tobacco. The proportion of tobacco use was highest in those above 40 years in both males and females. Alcohol was consumed by 11.1% males; proportion of alcohol consumed in males was only 3.3% below the age of 30 years and increased with the age. Only one of the studied women consumed alcohol. History of physical activities of individuals revealed 40% had a sedentary lifestyle (40.8% males and 39.7% females). Average salt consumption was 8.3 ± 3.3 g/day, whereas WHO recommends less than 5 g/day. It was more than 5 g/day in 88.0% subjects and was more than 10 g/day in 21.6% (Tables 1 and 2). Prevalence of hypertension was not significantly different in these groups, even when patients of known hypertension were excluded (Table 3). Average oil + ghee consumption was 37.8 ± 15.8 g/day in males and 29.8 ± 13.5 g/day in females (32.3 ± 14.9 g/day, both sexes). Prevalence of hypertension was 23.1%, which was 22.6% in males and 23.4 in females ($p = 0.7$). Prevalence of hypertension was 22.8% in females not using tobacco against 31.1% in those using tobacco ($p = 0.0001$), whereas none of the women smoked. Prevalence of hypertension in those with education below primary school was 26.5% compared to 19.2% in those with education of 6th to 12th standard ($p = 0.001$) and 11.6% in those with professional education or graduation and above ($p = 0001$).

Table 4 shows that prevalence of hypertension was not different in people consuming oil up to 25 g/day and those consuming more than 25 g/day in nonusers of ghee as well as those who consumed ghee up to 15 g per day (Table 4). Among high ghee consumers (> 15 g/day) prevalence of hypertension was 32.0% in those consuming oil more than 25 g/day as compared to 22.9% in those consuming oil up to 25 g/day ($p = 0.02$).

Discussion

The study has revealed a high prevalence of hypertension (23.1%) in a rural population of desert region of Rajasthan, India. Among behavioural risk factors for CVD, salt consumption, oil and ghee consumption was high and the prevalence of truncal obesity, sedentary lifestyle and tobacco use was high. Proportion of subjects consuming salt more than 5 g/day was very high (88.0%) in the present study whereas the same was only 34.2% in Pune

Table 1. Characteristics of the studied population

	Males	Females
Number (n)	650	1175
Mean age (years)	43.3 ± 16.1	42.1 ± 15.3
Literacy (%)	80.0	39.7
Mean body mass index (BMI) (kg/m^2)	20.4 ± 3.4	20.9 ± 4.0
Mean waist circumference (cm)	74.7 ± 11.3	68.9 ± 10.5
Mean hip (cm)	81.9 ± 6.6	82.4 ± 7.8
Mean waist hip ratio (WHR)	0.91 ± 0.092	0.83 ± 0.0795
Mean salt consumption (g/adult person/day)	9.6 ± 3.4	7.5 ± 2.9
Mean ghee consumption (g/adult person/day)	13.0 ± 10.4	9.9 ± 8.0
Mean oil consumption (g/adult person/day)	24.9 ± 10.8	19.5 ± 9.1
Tobacco use (%)	58.3	7.1
Alcohol consumption (%)	11.1	0.1
Sedentary lifestyle (%)	40.8	39.7

Table 2. Percentage prevalence of lifestyle related risk factors for cardiovascular diseases in rural population according to sex and age

	Age group (yrs)					
	20–29	30–39	40–49	50–59	60–99	All ages
Number						
Males	151	146	114	102	137	650
Females	274	308	218	170	205	1175
BMI > 24.99 (%)						
Males	2.0	9.6	16.7	20.6	13.9	11.7
Females	4.0	11.7	21.6	19.4	21.0	14.5
BMI > 23 (%)						
Males	9.3	21.2	30.7	27.5	25.5	22.0
Females	12.4	20.1	36.2	31.2	34.1	25.4
Truncal obesity* (%)						
Males (WHR > 0.9)	17.2	45.9	55.3	73.5	74.5	51.2
Females (WHR > 0.8)	44.2	52.6	69.7	77.1	82.9	62.6
Hypertension (140/90 + mmHg or taking antihypertensive medicine) (%)						
Males	4.6	7.5	23.7	36.3	47.4	22.6
Females	4.4	12.3	21.6	38.2	55.1	23.4
Tobacco use (%)						
Males	43.7	58.9	67.5	64.7	61.3	58.3
Females	2.9	6.2	10.1	6.5	11.7	7.1
Alcohol (%)						
Males	3.3	12.3	16.7	18.6	8.0	11.1
Females	0.0	0.3	0.0	0.0	0.0	0.1
Sedentary lifestyle (%)						
Males	38.4	27.4	30.7	37.3	68.6	40.8
Females	33.6	18.2	24.8	53.5	84.9	39.7
Salt consumption >10 g/day (%)						
Males	37.7	37.0	36.8	40.2	24.1	34.9
Females	13.9	11.7	15.6	17.6	14.6	14.3
Salt consumption >5 g/day (%)						
Males	96.7	98.6	98.2	97.1	94.9	97.1
Females	85.4	82.5	87.2	80.0	78.5	83.0
Oil + ghee consumption >40 g/day (%)						
Males	37.7	41.1	45.7	50.0	32.3	40.5
Females	25.0	16.9	18.3	22.9	15.3	19.6

*WHR > 0.9 in males and WHR > 0.8 in females.

in subjects above 30 years age[7]. Though daily consumption of salt ranges between 9.1 and 11.4 g in Haryana and was 8.8 and 9.9 g (150–169 mmol) per day[8] in salted-tea drinking population of Northern Kashmir[9,10]. Average salt consumption of 8.2 ± 3.1 g/day can be considered on a higher side as many public health agencies recommend universal restriction of dietary sodium to 100 mmol (5.8 g/day) or less per day[11] though in most populations, salt intake is between 100 and 200 mmol/d (5.8–11.7 g/day)[12]. Since salt consumption is restricted after diagnosis of hypertension, in the present study prevalence of hypertension was not found higher in those consuming more salt. The limitation of the present study is that salt consumption has been recorded at family level and has been calculated by 'consumption unit' method for individuals, this method might hide the individual variations in salt intake. This may also be the reason of not getting any association between salt intake and hypertension.

Mean oil + ghee consumption of 32.3 g/day per person is also high as visible fat intake is 27.9 g/day in adults of Punjab[13] and of 10.5 g/day in tribal women of India[14]. Consumption of saturated fats was 9.5–11.5 g/day in slum dwellers in India[15]. Higher dietary fats have also been found associated with high blood pressure and higher risk of CVD[16,17]. Oils used included poly-unsaturated non-hydrogenated vegetable oils (such as soyabean oil and groundnut oil), which are liquid at room temperature. The oils that are relatively high in saturated fats (such as coconut oil or palm oil) and thus semi-solid or solid at room temperature were not used by the studied population. Palm oil users are more likely to have myocardial infarction than users of polyunsaturated non-

Table 3. Prevalence of hypertension according to risk factors and sex

Risk factor	Percentage prevalence of hypertension	
	Males (n = 650)	Females (n = 1175)
Oil + ghee consumption		
Up to 40 g/day	20.7	22.0
>40 g/day	26.2	29.8
		p = 0.016*
Obesity		
BMI < 25	19.9	19.8
BMI 25+	43.4	44.7
	p = 0.000	p = 0.000
Truncal obesity (defined as WHR > 0.9 for males and WHR > 0.8 for females)		
Truncal obesity absent	13.9	11.8
Truncal obesity present	30.9	30.37
	p = 0.000	p = 0.000
Lifestyle		
Heavy worker	10.1	14.3
Moderate worker	20.6	15.8
Sedentary worker	29.4	34.9
	p = 0.003	p = 0.000
Tobacco		
Uses tobacco	23.0	31.1
Does not use tobacco	22.1	22.8
Alcohol		
Consumes alcohol	37.5	NA
Does not consume alcohol	20.8	
	p = 0.001	
Salt consumption (all subjects)		
Up to 10 g/day	23.4	22.9
>10 g/day	21.1	26.2
Salt consumption (excluding subjects who knew they have hypertension)		
Up to 10 g/day	12.3	15.2
>10 g/day	11.7	17.0
	(n = 538)	(n = 1047)

*p value is mentioned only where difference is significant.

hydrogenated vegetable oils like soybean oil[18]. The systematic review on aspects of diet and heart health carried out by the Thoracic Dietitians Interest Group, a specialist group of the British Dietetic Association suggested that reduction in saturated fat and substitution with unsaturated fats is likely to reduce cardiovascular events[19]. There is strong and consistent evidence from metabolic and clinical studies that diets high in unsaturated fat are more effective in reducing CVD risk than low-fat diets. A quantitative estimation of effects on risk factors indicates that even if increasing unsaturated fat intake at the expense of carbohydrates would produce some weight gain in the long-term, the net effect on CVD risk is probably beneficial[20]. This indicates that dietary polyunsaturated non-hydrogenated vegetable oils may rather have beneficial effect on hypertension and CVD. In this context, examination of data revealed that the prevalence of hypertension was not different in people consuming oil up to 25 g/day and those consuming more than 25 g/day in nonusers of ghee as well as those who consumed ghee up to 15 g/day. Among high ghee consumers (> 15 g/day), prevalence of hypertension was significantly higher in those consuming oil more than 25 g/day compared to those consuming oil up to 25 g/day. These observations indicate that higher dietary polyunsaturated non-hydrogenated vegetable oils were associated with higher risk of hypertension rather than having a beneficial effect, which is in contrast to earlier studies[19,20]. The data rather indicate that effect of ghee or oil consumption on hypertension is not different in this population. Limitation of the present study is that individual dietary intake was not recorded and consumption of fats and salt at family level was used to derive individual intake. The inverse graded relationship of education and prevalence of hypertension was observed by us, which has also been reported by Reddy *et al.*[21].

Prevalence of obesity (BMI > 24.99) was 13.4% in our study, which is much higher than 2.3% observed in

Table 4. Prevalence of hypertension according to consumption of ghee and oil

	Mean ghee consumption					
	0.000 g/day		0.1 to 15 g/day		> 15 g/day	
	Mean oil consumption up to 25 g/day/person	Mean oil consumption > 25 g/day/person	Mean oil consumption up to 25 g/day/person	Mean oil consumption > 25 g/day/person	Mean oil consumption up to 25 g/day	Mean oil consumption > 25 g/day
N	234	99	806	190	271	225
Mean BMI	19.7 ± 3.2	19.7 ± 3.1	20.6 ± 3.7**	20.9 ± 4.1**	21.3 ± 3.8**	21.8 ± 4.1*
Mean waist	68.5 ± 9.4**	69.5 ± 9.1**	69.8 ± 10.7**	71.3 ± 12.1**	73.5 ± 11.7**	74.7 ± 12.2**
Mean WHR	0.847 ± 0.078**	0.868 ± 0.082**	0.851 ± 092**	0.861 ± 0.092**	0.875 ± 0.090**	0.887 ± 0.096**
Mean hip	80.7 ± 6.2**	80.1 ± 6.3**	81.8 ± 7.3**	82.5 ± 7.8**	83.8 ± 7.7**	84.0 ± 8.0**
Mean ghee consumption (g/day)	0.0	0.0	8.5 ± 3.3**	10.0 ± 3.2**	22.0 ± 7.9**	23.3 ± 6.7**
Prevalence of hypertension (%)	18.8	19.2	22.7	22.1	22.9*	32.0*

*p = 0.02; **p = 0.001.

National Family Health Survey[22] and 5.1–5.2% in rural Wardha[23]. Prevalence of obesity has been found to be very high in females compared to males in India[24–28], similar observation has been made in our studies. In the present study, females had higher prevalence of abdominal obesity than males, which has also been found in Wardha[23], Bengal[29], Delhi[30], Dhaka[31], Chennai[32] and Jaipur[33]. Overweight is associated with high rates of CVD deaths, especially sudden death among men and congestive heart failure among women[34]. The high death rate might occur largely as a consequence of the influence of overweight on blood pressure, blood lipid levels, and the onset of diabetes[34]; however, a report from the Framingham Study indicates that overweight is also an independent risk factor for CVD[35].

A review of 43 epidemiologic studies in 1987 indicated that physical activity reduces the risk of CHD[36]. The relative risk for CHD associated with physical inactivity is approximately 1.9, slightly lower than the relative risks associated with increased systolic blood pressure (2.1), cigarette smoking (2.5) and elevated serum cholesterol levels (2.4)[38]. In the present study, 40% subjects had a sedentary lifestyle, while in Kolkata 85.4% women and 75.4% men were leading sedentary lives[39]. Several studies indicate that endurance exercise training among patients with documented CHD is associated with reduced morbidity and mortality[40,41] and that physical activity might improve the likelihood of survival from a myocardial infarction[42]. In addition, evidence documents an association between regular, moderate-intensity physical activity and the lowering of several other risk factors for CVD, including blood lipid levels, resting blood pressure among persons with borderline hypertension, body composition and overweight, and glucose tolerance and insulin sensitivity[43].

Use of tobacco and betel quid for chewing is a characteristic of our population. We combined cigarette smoking and other forms of tobacco use together because reporting only cigarettes smoking would underreport the tobacco use in this society. In the present study, 58.3% males and 7.1% females used tobacco. In the industrial population of Chennai with similar prevalence of hypertension[44], use of tobacco in any form was present in 22.9% of men and 0.5% of women. Data of Indian National Family Health Survey showed that 18.4% subjects smoked 21.0% and chewed tobacco[45]. In Pune only 16% adults used tobacco[46]. Studies have shown that cardiovascular effects of chewable tobacco are similar to those of cigarette smoking, but the age adjusted relative risk of dying from CVD is lower with smokeless tobacco than tobacco smoking[46,47]. The present study also revealed significantly higher prevalence of hypertension in women using smokeless tobacco. Cigarette smoking has also been reported to act synergistically with other known risk factors for CVD[48]. We found very high prevalence of hypertension, as compared to findings of Gupta *et al.*[2] from Jaipur. High blood pressure levels, both systolic and diastolic, have been shown to be positively and linearly related to the risks of stroke, CHD, heart failure and renal disease[49].

Considering high prevalence of hypertension in rural desert area, the results of this study underline the need for increasing community awareness about behavioural risk factors for CVD like tobacco use, high salt intake, sedentary lifestyle and higher consumption of dietary fats leading to obesity.

1. NCHS, Health United States, Hyattsville, MD: US Department of Health and Human Services, Public Health Service, CDC, National Center for Health Statistics, May 1996, DHHS Publication No. (PHS), 1995, pp. 96–1232.
2. Gupta, R., Trends in hypertension epidemiology in India. *J. Hum. Hypertens.*, 2004, **18**, 73–78.
3. Chobanion, A. V., Bakris, G. L. and Black, H. R., 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**, 2560–2572.
4. World Health Organization, WHO STEPS Instrument (Core and Expanded). The WHO STEPwise approach to chronic disease risk factor surveillance (STEPS) – Instrument v2.1. Geneva, assessed on 28 March 2010; http://www.who.int/chp/steps/STEPS_Instrument_v2.1.pdf
5. World Health Organization, International Association for the Study of Obesity and International Obesity Task Force. The Asia Pacific Perspective: Redefining Obesity and its Treatment, Regional Office for the Western Pacific of the World Health Organization. Health Communications Australia Pty Limited, St Leonards, Australia, 2000, pp. 22–29.
6. Webb, G. P., *Nutrition: A Health Promotion Approach*, Arnold, London, 2002, 2nd edn, p. 186.
7. Agrawal, V. K., Basannar, D. R., Sing, R. P., Dutt, M., Abraham, D. and Mustafa, M. S., Coronary risk factors in a rural community. *Indian J. Public Health*, 2006, **50**, 19–23.
8. Punia, D., Yadav, S. K., Gupta, M. and Khetarpaul, N., Note: storage practices, salt intake and iodine content of salt consumed in rural households of Haryana State, North India. *Nutr. Health*, 2002, **16**, 337–342.
9. Mir, M. A. and Newcombe, R., The relationship of dietary salt and blood pressure in three farming communities in Kashmir. *J. Hum. Hypertens.*, 1988, **2**, 241–246.
10. Mir, M. A., Mir, F., Khosla, T. and Newcombe, R., The relationship of salt intake and arterial blood pressure in salted-tea drinking Kashmiris. *Int. J. Cardiol.*, 1986; **13**, 279–288.
11. Alderman, M. H. and Cohen, H. W., Impact of dietary sodium on cardiovascular disease morbidity and mortality. *Curr. Hypertens. Rep.*, 2002, **4**, 453–457.
12. Alderman, M. H., Dietary sodium and cardiovascular health in hypertensive patients: the case against universal sodium restriction. *J. Am. Soc. Nephrol.*, 2004, **15**(Suppl.), S47–S50.
13. Bains, K. and Kaur, J., Food and nutrient intake in relation to cardiovascular disease among rural males of Punjab, India. *Asia Pac. J. Clin. Nutr.*, 2004, **13**(Suppl.), S95.
14. Agrahar-Murugkar, D. and Pal, P. P., Intake of nutrients and food sources of nutrients among the Khasi tribal women of India. *Nutrition*, 2004, **20**, 268–273.
15. Misra, A., Sharma, R., Pandey, R. M. and Khanna, N., Adverse profile of dietary nutrients, anthropometry and lipids in urban slum dwellers of northern India. *Eur. J. Clin. Nutr.*, 2001, **55**, 727–734.
16. Goel, N. K. and Kaur, P., Dr P.C. Sen Memorial Award – 1994. Role of various risk factors in the epidemiology of hypertension in

a rural community of Varanasi district. *Indian J. Public Health*, 1996, **40**, 71–76.
17. Hooper, L. *et al.*, Dietary fat intake and prevention of cardiovascular disease: systematic review. *BMJ*, 2001, **322**, 757–763.
18. Kabagambe, E. K., Baylin, A., Ascherio, A. and Campos, H., The type of oil used for cooking is associated with the risk of nonfatal acute myocardial infarction in Costa Rica. *J. Nutr.*, 2005, **135**, 2674–2679.
19. Mead, A. *et al.*, Dietetic guidelines on food and nutrition in the secondary prevention of cardiovascular disease – evidence from systematic reviews of randomized controlled trials (second update, January 2006). *J. Hum. Nutr. Diet.*, 2006, **19**, 401–419.
20. Zock, P. L., Do favourable effects of increasing unsaturated fat intake on cardiovascular disease risk outweigh the potential adverse effect on body weight? *Int. J. Obes. (London)*, 2006, **30**(Suppl.), S10–S15.
21. Reddy, K. S. *et al.*, Educational status and cardiovascular risk profile in Indians. *Proc. Nat. Acad. Sci. USA*, 2007, **104**, 16263–16268.
22. Agrawal, P. and Mishra, V., Covariates of overweight and obesity of women in north India. *Population Health Sci.*, 2004, **116**, 3–34; http://www.eastwestcenter.org/stored/pdfs/POPwp116.pdf, accessed on 27 December 2006.
23. Deshmukh, P. R., Gupta, S. S., Dongre, A. R., Bharambe, M. S., Maliye, C., Kaur, S. and Garg, B. S., Relationship of anthropometric indicators with blood pressure levels in rural Wardha. *Indian J. Med. Res.*, 2006, **123**, 657–664.
24. Mohan, V. and Deepa, R., Obesity and abdominal obesity in Asian Indians. *Indian J. Med. Res.*, 2006, **123**, 593–596.
25. Zargar, A. H. *et al.*, Prevalence of obesity in adults – an epidemiological study from Kashmir Valley of Indian subcontinent. *J. Assoc. Phys. India*, 2000, **48**, 1170–1174.
26. Gopinath, N., Chadha, S. L., Jain, P., Shekhawat, S. and Tandon, R., An epidemiological study of obesity in adults in the urban population of Delhi. *J. Assoc. Phys. India*, 1994, **42**, 212–215.
27. Gopalan, C., Obesity in the urban middle class. *NFI Bull.*, 1998, **19**, 1–4.
28. Mohan, V., Shanthirani, S., Deepa, R., Premalatha, G., Sastry, N. G. and Saroja, R., Intra urban differences in the prevalence of the metabolic syndrome in southern India – The Chennai Urban Population Study (CUPS-4). *Diabet. Med.*, 2001, **18**, 280–287.
29. Das, M. and Bose, K., Presence of high rates of overweight and obesity among adult Marwaris of Howrah, West Bengal, India. *Coll. Anthropol.*, 2006, **30**, 81–86.
30. Misra, A., Pandey, R. M., Devi, J. R., Sharma, R., Vikram, N. K. and Khanna, N., High prevalence of diabetes, obesity and dyslipidaemia in urban slum population in northern India. *Int. J. Obes. Relat. Metab. Disord.*, 2001, **25**, 1722–1729.
31. Zaman, M. M., Choudhury, S. R., Ahmed, J., Numan, S. M., Islam, M. S. and Yoshiike, N., Non-biochemical risk factors for cardiovascular disease in general clinic-based rural population of Bangladesh. *J. Epidemiol.*, 2004, **14**, 63–68.
32. Deepa, M., Farooq, S., Deepa, R., Manjula, D. and Mohan, V., Prevalence and significance of generalized and central body obesity in an urban Asian Indian population in Chennai, India (CURES: 47). *Eur. J. Clin. Nutr.*, 2009, **63**, 259–267.
33. Gupta, R., Gupta, V. P., Bhagat, N., Rastogi, P., Sarna, M., Prakash, H. and Deedwania, P. C., Obesity is major determinant of coronary risk factors in India: Jaipur Heart Watch studies. *Indian Heart J.*, 2008, **60**, 26–33.
34. Foster, W. R. and Burton, B. T. (eds), National Institutes of Health Consensus Development Panel on the Health Implications of Obesity. *Ann. Intern. Med.*, 1985, **103**(Suppl. 6), 1073–1077.
35. Hubert, H. B., The importance of obesity in the development of coronary risk factors and disease: the epidemiological evidence. *Annu. Rev. Public Health*, 1986, **7**, 493–502.
36. Powell, K. E. *et al.*, Physical activity and the incidence of coronary heart disease. *Annu. Rev. Public Health*, 1987, **8**, 253.
37. Pooling Project Research Group. Relationship of blood pressure, serum cholesterol, smoking habit, relative weight and ECG abnormalities to incidence of major coronary events: final report of the Pooling Project. *J. Chronic Dis.*, 1978, **31**, 202–306.
38. Gupta, R., Gupta, H. P., Keswani, P., Sharma, S., Gupta, V. P. and Gupta, K. D., Coronary heart disease and coronary risk factor prevalence in rural Rajasthan. *J. Assoc. Phys. India*, 1994, **42**, 24–26.
39. Ghosh, A., Effects of socio-economic and behavioural characteristics in explaining central obesity – a study on adult Asian Indians in Calcutta, India. *Coll. Anthropol.*, 2006, **30**, 265–271.
40. May, G. S., Eberlein, K. A., Furberg, C. D., Passamani, E. R. and DeMets, D. L., Secondary prevention after myocardial infarction: a review of long term trials. *Prog. Cardiovasc. Dis.*, 1982, **24**, 331–352.
41. O'Connor, G. T. *et al.*, An overview of randomized trials of rehabilitation with exercise after myocardial infarction. *Circulation*, 1989, **80**, 234–244.
42. Paffenbarger Jr, R. S., Wing, A. L. and Hyde, R. T., Physical activity as an index of heart attack risk in college alumni. *Am. J. Epidemiol.*, 1978, **108**, 161–175.
43. CDC, *Physical Activity and Health: A Report of the Surgeon General*, Atlanta: US Department of Health and Human Services, CDC, National Center for Chronic Disease Prevention and Health Promotion, President's Council on Physical Fitness and Sports, 1996.
44. Mohan, V., Deepa, M., Farooq, S., Prabhakaran, D. and Reddy, K. S., Surveillance for risk factors of cardiovascular disease among an industrial population in southern India. *Natl. Med. J. India*, 2008, **21**(1), 8–13.
45. Subramanian, S. V., Davey Smith, G. and Subramanyam, M., Indigenous health and socioeconomic status in India. *PLoS Med.*, 2006, **3**, e421.
46. Yusuf, S., Reddy, S., Onpuu, S. and Anand, S., Global burden of cardiovascular disease. Part II: variations in cardiovascular disease by specific ethnic groups and geographic regions and prevention strategies. *Circulation*, 2001, **104**, 2855–2864.
47. Teo, K. K. *et al.*, INTERHEART study investigators. Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: a case-control study. *Lancet*, 2006, **368**, 647–658.
48. Pathobiological Determinants of Atherosclerosis in Youth (PDAY) Research Group. Relationship of atherosclerosis in young men to serum lipoprotein cholesterol concentrations and smoking. *JAMA*, 1990, **264**, 3018–3024.
49. MacMahon, S. *et al.*, Blood pressure, stroke, and coronary heart disease. Part 1, prolonged differences in blood pressure: prospective observational studies corrected for the regression dilution bias. *Lancet*, 1990, **335**, 765–774.

ACKNOWLEDGEMENTS. We are grateful to World Health Organization for sponsoring the project 'Epidemiology of essential hypertension in arid population of Rajasthan', under which the data presented in this article were collected.

Received 21 October 2009; revised accepted 21 June 2010