Coronary heart disease risk-factor profile in a lower middles class urban community in Pakistan

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استعراض عوامل اختطار أمراض القلب التاجية في مجتمع حَضَري ضمن أفراد أدنى الطبقة المتوسطة في باكستان

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الخلاصة: قام الباحثون بتعيين مُرْتَسَم عوامل الاختطار ومعدلات انتشار أمراض القلب التاجية في مدينة كراتشي. كما قاموا بقياس تأثير الحياة الحضرية على مُرْتَسَم عوامل الاختطار في المجتمع، وذلك بمقارنته بنتائج المسح الوطني الذي أجري في باكستان خلال الفترة من 1990–1994، وكذلك المسح الوطني الصحي الثالث. ولقد تم استبعاد مَنْ كانت أعمارهم دون الثامنة عشرة وكذلك الحوامل، إضافة إلى أصحاب المعدلات القصوى من مَنْسَب كتلة الجسم، وسرعة ضربات القلب، والطول، وحجم الخصر. وكان المعدل العام لانتشار الإصابة بارتفاع ضغط الدم 23٪ لدى كل من الرجال والنساء، ونسبة ارتفاع الكولستيرول في الدم 17٪ لدى الرجال و22٪ لدى النساء ($P < 0.001$). وشوهد ارتفاع السكر في الدم لدى 5٪ من كل من الرجال والنساء، وكانت نسبة البدانة 33٪ لدى الرجال و47٪ لدى النساء ($P < 0.001$). وبمقارنة هذه المعطيات بمعطيات المسح الصحي الوطني الباكستاني، كانت معدلات انتشار البدانة وارتفاع ضغط الدم وارتفاع الكولستيرول في الدم ومعدل الخصر والأرداف كلها أعلى لدى الأشخاص الذين هم موضوع هذه الدراسة. وبمقارنة معطيات المسح الصحي الوطني الباكستاني ونتائج هذا المسح، بنتائج المسح الوطني الصحي الثالث ومسح الفحص الغذائي الذي أجري في الولايات المتحدة، جاءت القِيَم الوسطية العامة لمَنْسَب كتلة الجسم والكولستيرول المصلي ومعدل الخصر والأرداف كلها أعلى في المجتمع الأمريكي، بينما كانت القِيَم الوسطية العامة أقل بالنسبة لضغط الدم الانبساطي وغلوكوز الدم.

ABSTRACT We determined the risk-factor profile and prevalence of coronary heart disease in Metroville, a lower middle class urban community in Karachi, and compared them to the Pakistan health survey PNHS 1990–94, and the US health and nutrition survey 1988–94 NHANES111. Subjects < 18 years and pregnant women were excluded as were people with extreme ranges SMI, heart rate, height and waist. The prevalence of hypertension was 23% in men and women, hypercholesterolaemia was 17% in men and 22% in women (***P*** < 0.001). Hyperglycaemia was present in 5% of men and women and obesity in 33% of men and 47% of women (***P*** < 0.001). Compared to PNHS, the prevalences of obesity, hypertension, hypercholesterolaemia and WHR were higher in our population. Mean values of RMI, cholesterol, WHR were higher in the US population while mean values were lower for diastolic blood pressure and blood glucose.

Le profil des facteurs de risque de coronaropathies dans une communauté urbaine de classe moyenne inférieure au Pakistan

RÉSUMÉ Nous avons déterminé le profil des facteurs de risque et la prévalence des coronaropathies à Metroville, communauté urbaine de classe moyenne inférieure à Karachi, et les avons comparést à l'enquête nationale de santé réalisée au Pakistan de 1990 à 1994, enquête et á l' d'examen de la santé et de la nutrition effectuée de 1988-1994 aux États-Unis NHANES III. Les sujets ayant moins de 18 ans et les femmes enceintes ont été exclus ainsi que les fourchettes extrêmes pour l'IMC, la fréquence cardiaque, la taille et le tour de taille. La prévalence de l'hypertension s'élevait à 23 % chez les hommes et les femmes, l'hypercholestérolémie était de 17 % chez les hommes et de 22 % chez les femmes ($p < 0,001$). Une hyperglycémie était présente chez 5 % des hommes et des femmes et l'obésité chez 33 % des hommes et 47 % des femmes ($p < 0,001$). Par rapport à l'enquête nationale sur la santé au Pakistan, la prévalence de l'obésité, de l'hypertension, de l'hypercholestérolémie ainsi que le rapport tour de taille/tour de hanches étaient plus élevés dans notre population. Les valeurs moyennes pour l'IMC, le cholestérol et le rapport tour de taille/tour de hanches étaient supérieures dans la population nord-américaine tandis qu'elles étaient inférieures pour la pression artérielle diastolique et la glycémie.

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Introduction

The population in Pakistan, according to the 1998 Federal census, was 132.4 million and growing at the rate of 2.5% while the rate of growth of the urban population was 3.5%. At this rate the total population was expected to be 143.1 million in 2001 with an urban share of 47.7 million, representing 33% of the total population in Pakistan [*1*]. Pakistan is a developing country in which urbanization of a socioeconomically depressed rural population has resulted in admixture of ever increasing lower middle class urban communities with much smaller rich and high middle class communities. This epidemiological transition has resulted in a non-homogeneous population and has imposed on our developing country a double burden of high risk factors such as obesity and hypercholesterolemia and malnutrition and hypocholesterolaemia [*2*]. There is evidence to suggest that over the past 3 decades in Pakistan the incidence of coronary heart disease (CHD) has increased [*2–15*]. It has been observed that CHD occurs at an earlier age in the Pakistani population and the gender gap is narrower compared to women who reside in the more developed countries [*15*]. The effect of urbanization is apparent in the studies of immigrant Asians from the Indian subcontinent in Western Europe and North America in whom the incidence and severity of CHD is higher than the native population. Asian women in particular have severe forms of CHD [*17–20*]. In Pakistan changing lifestyles of lower middle class urban communities may be the operative factor in the observed increase in the incidence of CHD in Pakistan. The etiology of the CHD is not known, however the risk factors have a strong statistical correlation with the development of CHD and it has been shown that the modification of the risk factors leads to a reduction in this risk. Recently a long-term population-based study has shown a strong correlation of the incidence of CHD with prevalence of risk factors indicating that majority of the incidence of CHD in a population could be explained by the prevalence of the risk factors [*21*]. Thus by using data on the prevalence of risk factors in a community, it is possible to project the future burden of CHD in a population.

A community-based population study in Pakistan was undertaken by the National Institute of Cardiovascular Disease during 1967–68. Two communities, one semi-rural and the other urban, were studied but the targeted communities were not representative of the entire Pakistani population [*22*]. The overall prevalence of ischemic heart diseases in men was 2.3% in the rural and 4.7% in the urban populations and corresponding values for women over 25 years were 1.1% and 2.0%. The prevalence of hypertension was 16.3% in men and 20.4% in women in the rural community and 15.9% in men and 16.7% in women in the urban community [*22*]. A recent study of 3 urban communities around Karachi has shown that the prevalence of hypertension was 19.9% in men over 18 years and 20.9% in women so it appears that the prevalence has risen [*14*]. Comparison of hospital-based studies shows that the incidence of CHD among hospital admissions with heart ailments has increased dramatically from 1.7% in 1944–48 to 17.9% in 1958 to 41.8% in 1967 to 75.8% in men and 51.8% in women in 1981 [*11*].

The demographic and risk factor profile of a homogeneous population can be used to plan national preventive interventions but this cannot be done for the non-homogeneous population such as Pakistan. As industrialization proceeds in Pakistan, the rural communities will increasingly become urbanized and with employment their pur-

chasing power will increase which may adversely change their lifestyles. This change, we hypothesize, can be detected by comparing the risk-factor profile of the entire nation against the community under change.

The purpose our study was to present the demographics of Metroville, a low middle class urban community in Paksitan, and profile the risk factors of CHD and their prevalence rates. We also aimed to determine if the degree of increase in the risk-factor profile and prevalence rates in the urban community could be measured by comparing it with the Pakistan National Health Survey (PNHS) [*2*] and also a highly urbanized US population of the Third National Health and Nutrition Examination Survey 1988–1994 (NHANES111) [*23*].

Methods

Metroville is an urban community located 20 miles from down-town Karachi. Its ethnic groups comprise mainly Pathan and Punjabi people with some Sindis and others. It is in large measure composed of migrants from rural villages from all 4 provinces of Pakistan. The Metroville Health Study (MHS) was a US–Pakistan cooperative prospective study involving the National Institute of Cardiovascular Diseases in Karachi, Pakistan, the National Heart Lung and Blood Institute (NHLBI), Bethesda, Maryland and the University of North Carolina at Chapel Hill. It was designed to evaluate the efficacy of dietary intervention in the community [*24*]. Data were obtained at baseline examination of 399 (of 4296) Metroville households who responded to a letter of invitation to participate in the study and who volunteered for registration and were randomly assigned as treatment and control groups.

The demographic data included sex, age, ethnicity, profession, and household ownership and composition. A questionnaire was designed to evaluate awareness of cardiovascular diseases (CVD), including history of heart attacks, stroke, diabetes, hypertension, and tobacco smoking, chewing or sniffing. Educational level was determined by recording no formal education, primary school (4 years), high school (10 years) and college education (12 years). Physical examination included height (cm), weight (kg) and arm, waist and hip circumferences (cm). Blood pressure (mmHg) and heart rate were determined in the right arm in a sitting position; the diastolic pressure was taken at the disappearance of the 5th Korotkoff sound (K5), and K4 was also recorded. Blood glucose and serum cholesterol levels were determined at random times after meals using the Reflotron dry strip method. The calibration was done against the standard strips provided by Boeringer–Manheim Company. Specially trained doctors and laboratory technicians collected the demographic data, carried out the physical examination and made the chemical analyses. The health questionnaire was completed by the doctors and included history of heart attack, stroke, diabetes, hypertension and smoking chewing sniffing or smoking tobacco. Awareness about CHD was evaluated by questions regarding specifically the role of hypertension, smoking and obesity on the occurrence of heart attacks [*23*].

Subjects 18 years or older were eligible for inclusion in the MHS analysis. Only pre-intervention risk factors and relevant demographic data at baseline examination of MHS were included. Pregnant women and those under 18 years were excluded from the analysis. Also excluded from the analysis were those with measurements of

body mass index (BMI) beyond the range of 14 and 50 kg/m^2, heart rate beyond 30 and 140 beats/minute range, height beyond 102 and 200 cm range, and waist circumference beyond 27 and 145 cm range.

Statistical analysis

The MHS, PNHS and NHANES111 data were analysed in age groups of 18–19, 20–29, 30–39, 40–49, 50–59, 60–69 and ≥ 70 years. The percentages, means and standard deviations (SD) were calculated for various risk factors. Comparisons of risk factors were made by calculating age-adjusted means and the 25th, 50th, 75th and 90th percentile values for MHS, PNHS and NHANES111. Group means were compared by using the Student *t*-test and *P*-values < 0.05 were considered significant.

Results

Demographic data

The mean number of families per household was 1.22 (range 1–5), and the mean number of adults and children per household was 3.93 (range 1–12) and 4.17 (range 0–19) respectively. There were 2171 subjects included in the study, 1093 were children under 18 years and 1078 were adults, with adult to children ratio of 0.99. There were 1119 males and 1052 were females with male to female ratio of 1.06.

Mean monthly income of the households was 8321.5 Pakistani rupees (range 1500–90 000) (US$ 1 = 46 rupees at the time of the study). The ethnic distribution comprised 33.4% Punjabis, 45.3% Pathan 8.2 % Muhajir and 13.1% others. For 18 participants, ethnicity was not recorded.

Job and occupation distribution showed 10.8% self-employed, 5.6% government employees, 1.7% labourers, 36.4% students (school and college) and 21.5% were housewives. Pre-school children comprised 6.3% of the sample, 1.6 % were retired, 0.7% drivers and 8.2% had other jobs; in 7.3% the job was unknown. Thus out of 2171 participants, 50.0% (1086) including housewives were employed so that if one were to exclude the 1093 children most employable persons did have some employment.

The medical history questionnaire of 946 adults showed that CVD was reported in 27.1%, diabetes in 7.3% (5.0% on medication), stroke in 2.0%, heart attack in 4.7% and hypertension in 20.4% (10.3% on medication). Blood pressure ≥ 140/90 mmHg was noted in 15.7% and blood pressure >160/95 mmHg in 11.6%. There were 463 men and 483 women >18 years who responded to the questionnaire on smoking. Of these, 21.8% of men and 1.0% of women smoked tobacco, 11.7% of men and 4.6% of women chewed tobacco and 3.2% of men and 0.8% of women sniffed tobacco.

Education level showed that 27.5% were illiterate, 27.9% had primary education (4 years of schooling), 12.4% had middle school education and school-leaving certificate (10 years of schooling) and 15.5% had attended college. From the gender perspective, 40% of the women were illiterate while only 15% of the men were. In addition, 22.8% of the men had a college education compared with only 8.5% of the women.

Risk factors profile

Body mass index

The body mass index (BMI) profile of MHS and PNHS is presented in Tables 1 and 2. BMI increased with age in both sexes until the age of 70 years after which it fell slightly. The overall mean BMI in MHS men was 23.45 (SD 4.74) kg/m^2 and 25.22 (SD 5.84) kg/m^2 in women, women being

Table 1 **Coronary heart disease risk-factor profile in Metroville Health Study (MHS)**

Age group (years)	BMI (kg/m²)		WHR		SBP (mmHg)		DBP (mmHg)		TC (mg/dL)		Glucose (mg/dL)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Men												
18–19	19.68 (*n* = 39)	3.91	0.82 (*n* = 42)	1.07	114.12 (*n* = 42)	11.82	72.31 (*n* = 42)	7.70	127.90 (*n* = 41)	19.99	91.51 (*n* = 41)	21.63
20–29	21.79 (*n* = 114)	3.87	0.87 (*n* = 114)	0.06	115.40 (*n* = 113)	10.98	77.20 (*n* = 113)	10.07	149.11 (*n* = 108)	35.86	97.77 (*n* = 108)	19.89
30–39	23.29 (*n* = 112)	4.19	0.93 (*n* = 113)	0.10	115.96 (*n* = 113)	12.37	79.49 (*n* = 113)	9.58	172.21 (*n* = 107)	36.82	105.38 (*n* = 108)	28.61
40–49	25.29 (*n* = 126)	4.23	0.99 (*n* = 128)	0.19	123.06 (*n* = 127)	15.73	85.35 (*n* = 127)	11.01	181.31 (*n* = 123)	47.52	111.54 (*n* = 122)	45.7
50–59	25.15 (*n* = 5)	4.06	0.98 (*n* = 59)	0.09	132.69 (*n* = 59)	20.92	84.94 (*n* = 59)	11.66	173.80 (*n* = 54)	45.33	122.46 (*n* = 54)	44.16
60–69	24.68 (*n* = 23)	8.56	0.95 (*n* = 23)	0.17	138.74 (*n* = 23)	19.78	86.39 (*n* = 23)	14.86	177.85 (*n* = 20)	31.36	101.89 (*n* = 19)	18.16
≥70	23.20 (*n* = 13)	5.49	0.96 (*n* = 13)	0.23	134.31 (*n* = 13)	22.98	81.77 (*n* = 13)	11.16	173.92 (*n* = 12)	38.24	140.67 (*n* = 12)	57.65
All	23.45 (*n* = 485)	4.74	0.93 (*n* = 492)	0.14	121.08 (*n* = 490)	10.58	80.91 (*n* = 490)	11.32	165.82 (*n* = 465)	42.56	106.15 (*n* = 464)	35.88
Women												
18–19	20.53 (*n* = 31)	3.18	0.77 (*n* = 33)	0.06	111.92 (*n* = 23)	10.48	71.50 (*n* = 33)	10.39	155.73 (*n* = 30)	31.83	96.84 (*n* = 32)	16.90
20–29	22.98 (*n* = 121)	5.05	0.08 (*n* = 129)	0.07	110.87 (*n* = 128)	12.21	73.34 (*n* = 128)	10.35	152.73 (*n* = 122)	38.98	96.78 (*n* = 123)	19.29
30–39	25.85 (*n* = 137)	5.45	0.85 (*n* = 137)	0.07	117.10 (*n* = 134)	16.56	77.91 (*n* = 134)	11.06	175.98 (*n* = 131)	46.23	101.47 (*n* = 131)	28.34
40–49	27.64 (*n* = 100)	6.31	0.88 (*n* = 100)	0.09	126.55 (*n* = 99)	18.14	83.80 (*n* = 99)	12.25	187.80 (*n* = 92)	41.48	112.77 (*n* = 90)	43.95
50–59	27.10 (*n* = 45)	5.97	0.89 (*n* = 45)	0.07	132.69 (*n* = 44)	28.40	82.52 (*n* = 44)	12.69	192.21 (*n* = 43)	54.36	128.67 (*n* = 43)	57.34
60–69	26.43 (*n* = 29)	5.03	0.90 (*n* = 29)	0.07	144.47 (*n* = 29)	22.44	84.90 (*n* = 29)	11.95	187.21 (*n* = 28)	37.36	128.36 (*n* = 28)	41.86

Table 1 **Coronary heart disease risk-factor profile in Metroville Health Study (MHS) *(concluded)***

Age group	BMI (kg/m²)		WHR		SBP (mmHg)		DBP (mmHg)		TC (mg/dL)		Glucose (mg/dL)	
(years)	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
≥ 70	23.83 (*n* = 15)	4.87	0.89 (*n* = 15)	0.07	123.9 (*n* = 15)	21.21	71.87 (*n* = 15)	11.99	177.79 (*n* = 14)	48.93	125.33 (*n* = 15)	74.49
All	25.22 (*n* = 489)	5.84	0.85 (*n* = 488)	0.08	120.31 (*n* = 482)	19.83	78.12 (*n* = 482)	12.18	173.16 (*n* = 469)	45.32	107.04 (*n* = 462)	37.69

BMI = body mass index.
WHR = waist hip ratio.
SBP = systolic blood pressure.
DBP = diastolic blood pressure.
TC = total cholesterol.
SD = standard deviation.

more overweight than men ($P < 0.0001$) The BMI in PNHS also increased with age in both sexes and the overall BMI in men was 20.81 (SD 3.81) kg/m^2 compared to 21.47 (SD 4.45) kg/m^2 in women who were again more overweight than men ($P < 0.0001$) (Table 2). The comparison of overall BMI in MHS and PNHS showed that both women and men in MHS were more overweight ($P < 0.0001$).

In MHS overweight, defined as BMI > 25 kg/m^2 [*25*], was present in 33% of men compared to 12% of men in PNHS. In MHS 47% women were obese as against 20% of women in PNHS ($P < 0.0001$) (Table 3). Women were more overweight than men in both PNHS and MHS ($P < 0.001$). In both MHS and PNHS the prevalence of overweight in men increased with age. In women in MHS the trend was similar although the prevalence was much higher.

Waist-to-hip ratio

The overall mean waist-to-hip ratio (WHR) in men in MHS was 0.93 (SD 0.14) which was significantly higher than in women 0.85 (SD 0.08) ($P < 0.0001$) while in PNHS it was similar in both men and women. In MHS men the WHR increased with age and then fell slightly after 70 years (Table 1). The same trend was noted in women ($P < 0.0001$). In PNHS the WHR increased with age in both men and women. WHR ratio was significantly greater in MHS men than PNHS men ($P < 0.001$) and in PNHS women than MHS women ($P < 0.001$) (Table 3).

In PNHS 15% of men exceeded WHR = 0.96 [*25*] while in MHS 34% exceeded this ratio ($P < 0.0001$). In MHS men the prevalence of men with WHR > 0.96 was 2% in the 18–19-year age group and increased to 77% in those >70 years. This trend was also found in PNHS men although the rate was much lower.

Table 2 **Coronary heart disease risk-factor profile in the Pakistan National Health Survey (PNHS)**

Age group (years)	BMI (kg/m²)		WHR		SBP (mmHg)		DBP (mmHg)		TC (mg/dL)		Glucose (mg/dL)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Men												
18–19	19.43 (*n* = 264)	3.46	0.84 (*n* = 270)	0.04	116.25 (*n* = 271)	11.10	77.98 (*n* = 271)	8.67	132.3 (*n* = 260)	28.87	92.06 (*n* = 262)	15.45
20–29	20.68 (*n* = 818)	3.59	0.87 (*n* = 845)	0.11	117.04 (*n* = 845)	11.14	79.7 (*n* = 848)	9.12	143.96 (*n* = 820)	35.55	92.35 (*n* = 827)	18.69
30–39	21.12 (*n* = 32)	3.47	0.89 (*n* = 653)	0.06	115.35 (*n* = 657)	11.48	81.51 (*n* = 657)	10.51	157.08 (*n* = 634)	37.48	95.03 (*n* = 639)	29.58
40–49	21.79 (*n* = 457)	4.25	0.91 (*n* = 476)	0.07	118.36 (*n* = 476)	14.35	82.87 (*n* = 476)	9.92	162.85 (*n* = 457)	44.22	100.86 (*n* = 462)	30.63
50–59	20.74 (*n* = 368)	3.58	0.92 (*n* = 378)	0.07	121.88 (*n* = 380)	18.38	83.29 (*n* = 380)	10.82	159.89 (*n* = 367)	39.71	110.13 (*n* = 368)	60.80
60–69	21.07 (*n* = 303)	5.05	0.91 (*n* = 304)	0.08	126.54 (*n* = 310)	21.27	81.51 (*n* = 310)	12.12	157.16 (*n* = 300)	37.23	108.93 (*n* = 304)	45.57
70+	19.12 (*n* = 210)	3.51	0.90 (*n* = 221)	0.08	127.84 (*n* = 231)	25.29	78.71 (*n* = 231)	12.31	154.6 (*n* = 214)	37.42	109.91 (*n* = 217)	52.12
All	20.81 (*n* = 3052)	3.81	0.89 (*n* = 3191)	0.08	119.11 (*n* = 3172)	15.79	80.95 (*n* = 3113)	10.33	152.38 (*n* = 3052)	38.73	99.16 (*n* = 3079)	36.39
Women												
18–19	19.42 (*n* = 264)	2.87	0.85 (*n* = 239)	0.08	113.28 (*n* = 241)	11.34	73.38 (*n* = 241)	7.96	146.12 (*n* = 232)	32.90	95.53 (*n* = 236)	13.90
20–29	20.31 (*n* = 818)	3.87	0.87 (*n* = 846)	0.07	111.94 (*n* = 852)	11.60	73.79 (*n* = 852)	8.36	150.56 (*n* = 818)	33.99	96.48 (*n* = 832)	23.48
30–39	22.31 (*n* = 632)	5.22	0.9 (*n* = 673)	0.08	115.67 (*n* = 674)	15.01	77.16 (*n* = 674)	10.09	157.78 (*n* = 646)	38.02	100.73 (*n* = 651)	29.8
40–49	22.84 (*n* = 457)	5.33	0.91 (*n* = 539)	0.09	121.10 (*n* = 553)	20.23	79.32 (*n* = 553)	11.85	163.46 (*n* = 527)	38.62	105.32 (*n* = 530)	41.73
50–59	22.56 (*n* = 368)	5.29	0.92 (*n* = 380)	0.09	127.74 (*n* = 383)	24.85	81.6 (*n* = 383)	12.94	171.05 (*n* = 364)	42.22	113.53 (*n* = 369)	45.94
60–69	21.37 (*n* = 303)	4.96	0.92 (*n* = 265)	0.08	132.78 (*n* = 269)	24.02	81.34 (*n* = 269)	13.46	173 (*n* = 247)	46.82	115.28 (*n* = 253)	57.8

Table 2 **Coronary heart disease risk-factor profile in the Pakistan National Health Survey (PNHS) *(concluded)***

Age group	BMI (kg/m²)		WHR		SBP (mmHg)		DBP (mmHg)		TC (mg/dL)		Glucose (mg/dL)	
(years)	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
70+	20.19 (*n* = 210)	4.48	0.91 (*n* = 185)	0.10	133.12 (*n* = 184)	22.85	80.38 (*n* = 184)	11.89	175.34 (*n* = 180)	42.28	112.39 (*n* = 178)	45.06
All	21.47 (*n* = 3061)	4.84	0.89 (*n* = 3126)	0.09	119.4 (*n* = 3156)	19.38	77.42 (*n* = 315)	11.16	159.89 (*n* = 3614)	39.39	103.40 (*n* = 3049)	36.81

BMI= body mass index.
WHR= waist hip ratio.
SBP= systolic blood pressure.
DBP= diastolic blood pressure.
TC = total cholesterol.
SD = standard deviation.

Systolic blood pressure

The mean systolic blood pressure (SBP) in MHS men was 121.08 (SD 10.58) mmHg and 120.31 (SD 19.83) mmHg in women while in PNHS men the SBP was 119.11 (SD 15.79) mmHg and 119.4 (SD 19.38) mm Hg in women. The SBP in men and women was not significantly different in both studies. SBP was higher in MHS men than PNHS men ($P < 0.01$) but was not different in women. The SBP increased with age in both sexes in both studies until the age of 70 years when it fell.

Diastolic blood pressure

The mean diastolic blood pressure (DBP) increased with age in MHS as well as PNHS until 70 years when it tended to drop in both men and women (Tables 1 and 2). The mean DBP in MHS men was 80.91 (SD 11.32) mmHg compared to 78.12 (SD 12.18) mmHg in women ($P < 0.0001$). In PNHS the mean DBP was also higher in men [80.95 (SD 10.31) mmHg] than in women [77.42 (SD 11.10) mmHg] in women ($P < 0.0001$). Comparison of DBP in MHS and PNHS men showed no significant difference.

Hypertension was defined as SBP or DBP or both ≥ 140/90 mmHg [*26*]. The overall prevalence rate of hypertension was 18% in PNHS men and 23% in MHS men ($P = 0.008$) while 23% of MHS women had hypertension compared to 15% of PNHS women ($P < 0.0001$) (Table 3). In MHS and PNHS men and women there was a steady increase in the prevalence of hypertension with age.

Serum cholesterol

The mean total serum cholesterol in MHS men was 165.82 (SD 42.56) mg/dL and was higher in women 173.16 (SD 45.32) mg/dL ($P < 0.011$). In PNHS men the total cholesterol was 152.38 (SD 38.7) mg/dL

Table 3 **Prevalence of risk factors for coronary heart disease in men and women in the Pakistan in the National Health Survey (PNHS) and Metroville Health Study (MHS)**

Risk factor	Men					Women				
	PNHS		MHS		*P*-value	PNHS		MHS		*P*-value
	No.	%	No.	%		No.	%	No.	%	
Body mass index > 25 kg/m^2	3052	12	487	33	< 0.001	3061	20	486	47	< 0.001
WHR > 0.96 (men); > 0.86 (women)	3147	15	492	34	< 0.001	3127	85	488	76	< 0.001
Hypertension BP > 140/90 mmHg	3173	18	490	23	0.0013	3156	15	483	23	NS
Cholesterol > 200 mg/dL	3052	11	465	17	0.0004	3014	14	460	22	NS
Blood glucose > 140 mg/dL	3079	5	464	8	NS	3049	5	462	8	NS
Smoking	3083	35	488	35	< 0.001	3152	4	485	7	< 0.001

and again higher in women at 159.89 (SD 39.39) mg/dL ($P < 0.0001$). Serum cholesterol increased with age in both studies and comparison of MHS and PNHS showed significantly higher serum cholesterol in MHS men and women ($P < 0.0001$) (Tables 1 and 2).

Hypercholesterolaemia was defined as serum cholesterol exceeding 200 mg/dL [*27*]. The overall prevalence of hypercholesterolaemia was 17% in PNHS men versus 11% in MHS men ($P < 0.001$) and 22% in MHS women versus 14% in PNHS women ($P < 0.05$). The prevalence increased with age in both studies (Table 3).

Blood glucose

Random blood glucose profiles in MHS and PNHS are shown in Tables 1 and 2. Blood glucose levels in MHS men and women increased with age. The overall mean of 106.15 (SD 35.88) in MHS men was not significantly different from women [107.04 (SD 37.69) mg/dL]. In PNHS men the mean BG was 99.16 (SD 36.39) mg/dL and 103.40 (SD 36.81) mg/dL in women, which was significantly higher ($P < 0.0001$). Comparison of mean blood glucose levels in MHS with PNHS showed significantly higher values in MHS men ($P < 0.0001$) and women ($P = 0.048$).

The mean prevalence of hyperglycaemia, defined as blood glucose > 140 mg/dL, was 8% in MHS and 5% in PNHS men ($P < 0.0001$). The rates were the same in women (Table 3). The prevalence of hyperglycaemia increased with age in both MHS and PNHS men and women.

Smoking

Smoking was uncommon in women in both MHS and PNHS. The prevalence of smoking in women aged 18–19 years was 0% in both studies but the rate increased steadily with age. The prevalence of smoking among men was much higher in both studies; 17% of 18–19-year-olds smoked in MHS which increased to 69% in >70-year-olds, while 12% of 18–19-year-olds smoked in PNHS and the rate increased

with age to 33% among 60–69-year-olds. The overall prevalence was 35% in men in both studies and 7% and 4% in MHS and PNHS women respectively (Figure 1).

Comparative analysis

Comparisons of the MHS, PNHS and NHANES111 data were done by comparing the age-adjusted overall mean of each risk factor (Table 4) and age-adjusted percentile plots of each risk factors (data available on request). The BMI percentile plots showed that the BMI values were highest in NHANES111 followed by MHS and PNHS. The comparison was valid for women as well.

WHR comparisons revealed that in men WHR was highest in NHANES111 followed by MHS the values of the two were almost equal in the 75th to 90th percentiles. For women MHS and NHANES111 showed similar values except in highest percentiles where NHANES 111 were slightly higher.

Total serum cholesterol values were higher for both men and women in NHANES111 compared to MHS and PNHS were MHS had higher values in lower and middle percentiles and almost equal in higher percentiles.

SBP values were slightly higher in NHANES111 compared to MHS men and PNHS had values lower than the two. For the women MHS had the highest values followed by PNHS. The NHAHES111 females were close to PNHS in the lower percentiles and were lower than PNHS in the higher percentiles. For the DBP in both men and women the MHS had highest values followed closely by PNHS men and significantly lower in women while NHANES111 had the lowest values. The blood glucose level was highest in MHS followed by

Table 4 **WHO age-adjusted mean for risk factor in MHS, PNHS and NHANES111**

Variable	Men			Women		
	MHS	PNHS	US	MHS	PNHS	US
Systolic blood pressure (mmHg)	117.2 (3.5)	115.1 (2.1)	118.0 (3.0)	117.0 (3.6)	115.0 (2.9)	112.9 (3.2)
Diastolic blood pressure (mmHg)	79.0 (1.5)	77.5 (1.7)	70.4 (2.6)	76.7 (1.4)	73.5 (2.0)	66.8 (2.1)
Total cholesterol (mg/dL)	157.0 (6.0)	151.9 (2.9)	189.5 (5.5)	162.8 (6.1)	159.5 (2.9)	192.7 (6.1)
Glucose (mg/dL)	103.1 (4.2)	99.3 (2.1)	96.5 (1.8)	105.7 (3.5)	103.8 (2.1)	92.9 (2.1)
Haemoglobin (g/dL)	14.0 (0.2)	14.0 (0.2)	14.7 (0.2)	12.6 (0.1)	12.3 (0.1)	13.2 (0.05)
Body mass index (kg/m^2)	21.3 (1.0)	19.4 (0.7)	24.4 (0.9)	22.7 (1.2)	20.0 (0.7)	24.4 (0.9)
Waist to hip ratio	0.91 (0.015)	0.88 (0.009)	0.92 (0.13)	0.85 (0.012)	0.89 (0.007)	0.85 (0.009)
Heart rate (beats/ minute)	73.9 (4.1)	84.5 (1.1)	74.1 (1.0)	76.1 (4.3)	85.5 (1.0)	78.3 (1.0)

Values are means (standard error of the mean).
PNHS = Pakistan National Health Survey.
MHS = Metroville Health Study.
NHANES111 = Third National Health and Nutrition Examination Survey 1988-1994.

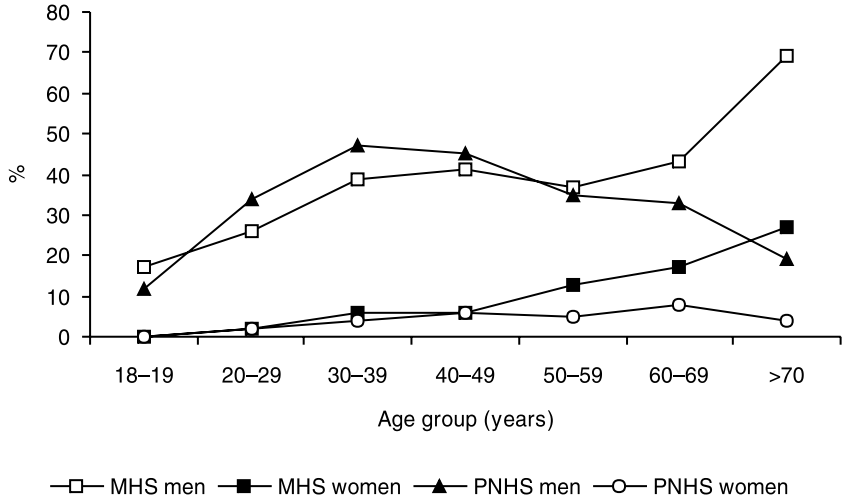

Figure 1 **Prevalence of smoking in men and women by age group in the Metroville Health Study (MHS) and the Pakistan National Health Survey (PNHS)**

PNHS and NHANES111 in both men and women.

Discussion

Our study showed that PNHS risk factor profiles, which represents the national average, could be used to compare the CHD risk factors profile of Metroville, a typical lower middle class urban community of a large metropolis of 10 million people. The degree of increase in levels of risk factors and increase in prevalence rates of CHD risk factors in Metroville could be quantified.

The data showed that in MHS compared to PNH, the risk factors profile of BMI, WHR, blood pressure, cholesterol and blood glucose were higher in Metroville. The risk factors profile and prevalence rates were worst for the women compared to men in both studies and in Metroville the women had higher levels of risk factors compared to PNHS women, which represents the national average. Recent reports from urban centres in Pakistan show increasing incidence of CHD and it seems likely that the high prevalence rates of hypertension, hypercholesterolaemia and obesity in Metroville and similar communities in Pakistan are being translated into increasing clinical CHD in urban Pakistan because a high profile of risk factors has been shown to translate into high prevalence rates [*21*]. Smoking was the only risk factor that was predominantly more prevalent in men; women did not smoke to any significant degree.

The demographic profile of Metroville was that of a lower middle class urban community and showed all the characteristics of the Pakistani population at large, the differences were quantitative rather than qualitative; for instance unemployment, illiteracy, low wages and a predominance of young people are all evident in MHS but are quantitatively less. Thus the MHS study population was characteristic of other ur-

ban communities in Pakistan [*2,14*]. The important difference between the urban and rural populations was in wages. Although low by modern standards, better wages in the urban population gave the population purchasing power which is a factor in changing the lifestyles. For example, smoking was less than 4% in those under 18 years but with the acquisition of employment this figure rose to 34% in 20–39-year-olds. The availability of jobs in the towns is a major reason for rural to urban migration. Our data show that compared to the PNHS population, adoption of urban lifestyles by the MHS population had adversely affected their risk-factor profile so that the overall mean levels of blood pressure, cholesterol, blood glucose and BMI were all higher in Metroville. This comparative risk-factor profile showed that urbanization increased socioeconomic status but worsened the risk factors. The process of urbanization is an integral part of industrialization in developing countries; thus it seems likely that the risk-factor profile of these urbanized communities in Pakistan and other similar populations will continue to change for the worse.

The high prevalence of risk factors such as hypercholesterolaemia, hypertension and obesity in a population with low average values of BMI and serum cholesterol seems paradoxical. The explanation lies in the demographic profile of Pakistan as delineated in the PNHS which showed that the population is not homogeneous and is composed of a low number of communities of high and middle socioeconomic status together with a much larger number of urban and rural communities of poor and lower socioeconomic status. The PNHS data are an average of this intermix and are skewed toward the majority poor and low socioeconomic population. The PNHS data have clearly defined this double burden of CHD and malnutrition in our population [*2*].

Increased levels of risk factors have been shown to translate into high prevalence rates of risk factors to the levels that are significantly associated with clinical events of CHD and mortality [*21*]. Our study showed that the prevalence of hypertension, smoking, hypercholesterolaemia, obesity and diabetes were significantly higher in MHS than PNHS and suggests that the MHS population and similar communities in the developing countries are at a higher risk of future CHD [*28–30*]. This observation explains the observed increasing incidence of CHD in urban Pakistan [*2–14*].

Both MHS and PNHS data showed a high prevalence of hypertension in our population. The reasons for high levels of DBP in our population are not clear although technical factors cannot be entirely excluded. Nonetheless the high DBP profile of all of the communities suggests that this observation is real. One can conjecture as to the reasons, which include high salt diet, low birth weight, obesity due to lack of exercise and genetic factors [*18*].

Compared to NHANES111 data from the USA, a country in which CHD is high, the risk-factor profile of the Pakistani population in the PNHS population had lower BMI, serum cholesterol and WHR, and higher DBP, blood glucose levels and heart rate. The population risk-factor profile allows the projection of the future burden of CHD and related circulatory diseases. Thus the risk of future CHD in Pakistan is expected to be less than the USA but is significant for diabetes and hypertension.

Comparison of the risk-factor profile of MHS and PNHS showed that risk factors were for the most part lower than NHANES111 values. This gap is due to the

lower socioeconomic status in Pakistan; however, as the urbanization increase, this gap will decrease and, as MHS showed, the risk-factor profile can change for the worse. For certain risk factors, such as blood pressure, this gap is decreasing. It is possible that there are technical reasons for the high blood pressure profile, such as variations in the accuracy of various operators, but this is unlikely because the prevalence of hypertension in Pakistan is similar to the US population. Some of the reasons for narrowing of the gap may be genetic but the association of obesity with hypertension suggests that environmental factors are significant.

It has been suggested that women of reproductive age are protected from the risk of CHD and in the industrialized world women tend to develop CHD 10 years later than men [*15*]. In Pakistan the male:female ratio of patients with myocardial infraction has been reported to be 3:1 and the gender age gap to be 5 years [*15*]. Data from India, where lifestyles of urban communities are similar to Pakistan, also support the observation of early onset of CHD in Asian women [*16–18,29,30*]. The high prevalence of risk factors in women in Pakistan thus appears to have translated into early and severe CHD in women [*15*]. For developing countries, CHD risk factors have been shown to largely explain the rate of CHD in a population and, with advancing age, the male/female gap of onset of CHD is eventually reversed. This effect has been reported to be associated with a proportionately higher age-related increase in the risk factors in women in the industrialized world. The early and severe CHD in Asian women has been variously ascribed to insulin resistance and genetically determined increased lipoprotein Lp(a) [*17,18,31*]. Urbanization and the sedentary home living conditions of Pakistani women may be the most important factor initiating obesity and the clustering of all other risk factors [*31*]. This hypothesis needs further elaboration and confirmation.

In conclusion our study showed that the degree of adverse change in the CHD risk-factor profile that has occurred in our urban lower-middle class community in Pakistan could be detected by comparing its CHD risk factors with the risk factor profile of PNHS and strongly indicates the effect of urbanization in worsening the risk-factor profile of our urban communities. Our study also showed that the comparative gender risk-factor profile was worse for women and the prevalence of risk factors was higher in women except for smoking. To the extent that risk factors in a population contribute to an increased incidence of cardiovascular disease, our study has provided an explanation for the observed early onset of CHD in Pakistani women. Our study supports the reported conclusion that ischaemic heart disease has emerged as the leading cause of morbidity and mortality in the developing world and suggests that urgent preventive strategies are needed to check the worsening lifestyles in the emerging urban communities in Pakistan and other developing countries. Urbanization needs to be planned so that towns can allow for healthy lifestyles for the entire population.

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