Evaluation and Comparison of Coronary Heart Disease Risk Factor Profiles of Children in a Country with Developing Economy

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Abstract

Objective: To define the risk factors (RF) profile and prevalence rates of high risk factors in an urban Pakistani community and compare it to the RF profile and prevalence rates of Pakistan National Health Survey.

Methods: The present study included RF relevant data of 400 house hold children selected by open invitation as a part of Metroville Health Study (MHS), a risk factor modification study which was a cooperation between National Heart Lung Blood institute (NHLBI) USA and National Institute of Cardiovascular Diseases Pakistan. The base line data of 389 girls and 417 boys age 5-17 was included. PMRC data of 5067 and NHANES III survey data of 10,252 US children was used for comparison with MHS. RF analyzed were height weight, SBP, DBP, BMI and serum cholesterol. Comparisons between MHS and PMRC and US were made by using two tailed student t test and of high RF were defined as those exceeding US standards and expressed as percentages.

Results: The RF factor profile of urban Metroville children was worse than the national average of PMRC children. Except for diastolic blood pressure in both boys and girls and SBP in PMRC boys, all other RF were less than US children. Prevalence rates were higher in urban Metroville community, i.e., MHS compared to the PMRC which represents national average data.

Conclusion: RF profile of Pakistani children has been presented and effect of urbanization demonstrated by comparing the PMRC and MHS RF profile. Hypertension in Pakistani children has emerged as a single most important RF requiring urgent prevention (JPMA 54:364;2004).

Introduction

Coronary heart disease (CHD) is the leading cause of death in developed countries, and the World Health Organization (WHO) reports suggest that the burden of CHD is increasing in developing countries.[1-4] The genesis of CHD is due to atherosclerosis and the causes of atherosclerosis are not known. However, several risk factors (RF) have been identified which bear a strong statistical association with the development of atherosclerosis and future CHD.[5] Some of these RF are genetically regulated, such as family history of premature CHD, diabetes mellitus, hypercholesterolemia and much of essential hypertension and obesity.[6,7] Inasmuch as these RF are related to genetic predisposition for atherosclerotic coronary disease in high-risk people, they have been found to be present during childhood. When abnormal RF are detected in childhood, they have a strong tendency to track to adulthood.[8,9] Thus, if it were possible to identify children with abnormal RF levels and modify the RF, in theory, future CHD would be preventable. This hypothesis is supported by experience in adults where modification of the RF has resulted in amelioration of CHD.[10]

Although results of longitudinal follow-up with intervention of RF during childhood are not yet available, recent studies have shown that childhood populations at risk of future CHD can be detected with reasonable certainty and risk factors can be modified with preventable strategies.[11,12] Thus, for each country with differing ethnic and socioeconomic populations, it has become possible to identify a CHD risk factor profile so that proper preventive efforts can be initiated. The age at which modification of risk factors is most protective is uncertain.[13] Recent data by Berenson et al[14] show that plaque formation in the coronary arteries starts as early as age 5 or 6, and increases dramatically in teenagers. The development of plaque formation in coronary arteries was strongly correlated with RF in affected children. Thus identification and comparing the RF profile of a developing country, with RF profiles of countries with high incidence of CHD should be helpful in planning intervention efforts.

Morbidity and mortality due to CHD are increasing in urban Pakistan.[15] It is evident that Pakistan urgently needs to develop RF modification and intervention strategies at the community level and possibly at the national level to prevent these increases. The purposes of this study are to:

1. Present RF profile and prevalence data of children aged 5-17 years in a lower middle class urban community of Metroville Health Survey (MHS).
2. Compare the RF profile and prevalence of MHS with Pakistan National Health Survey (PNHS) children conducted by PMRC and to high- risk NHANES111US children.

Subjects and Methods

Metroville is a lower middle class urban community located in the outer fringes of Karachi. It has a mixed ethnic population comprising of 46% Pathans, 34% Punjabis, 8% Mohajirs and 12% others. The MHS is a risk modification study and was planed and conducted by joint collaboration of US National Heart Lung and Blood Institute and National Institute of Cardiovascular Diseases Pakistan. Four hundred registered households in Metroville constituted the study population. There were 806 children (417 boys and 389 girls) between 5-17 years of age, in the MHS. Mean monthly income was 8,279 rupees. Forty-one percent of those employed in the community owned a business. The average number of persons in a household was eight. Among children under 19 years of age, 26% had no education, 65% had primary or middle school education, and 9% were in college. Among adults, 12% had no education, 23% had primary or middle school education and 65% had matric or college education. As part of the RF modification study of these 400 households conducted during 1995-1996, data on children were collected at the baseline assessment. Specially trained social workers and medical staff of the National Institute of Cardiovascular Diseases (NICVD) collected the data. Demographic data included height measured by a wall-mounted scale and weight measured on spring scales. Systolic and diastolic blood pressures (SBP, DBP) were measured on subjects in a sitting position, as recommended by the Second US Task Force on Blood Pressure in Children.[16] An average of the two readings was used. BMI was calculated as weight (kg)/ height (m^2), waist-hip ratio was defined as (waist girth/hip girth). Serum cholesterol was at baseline interview. The MHS was planned and conducted by joint efforts of the US National Heart, Lung, and Blood Institute and NICVD Pakistan.

The PMRC National Health Survey included all four provinces, and both rural and urban populations. The study was a collaboration of Pakistan Medical Research Council, Pakistan Bureau of Statistics, National Center of Health Statistics (NCHS) of disease control (CDC) and US public Health service. The final sample comprised of 960 urban households and 1,440 rural households. Data on 5067 children aged 5-17 years age (2669 boys and 2398 girls) from the PMRC survey[2] was included in this study.[6,15,16] Specially trained teams recorded SBP and DBP, height and weight. Serum cholesterol was determined by using Reflotron with a dry strip method. US NHANES 111 data of 10,252 children 5-17 years age, (5038 boys and 5214 girls) was used for comparison.[17]

Statistical Methods

The data was analyzed in groups of 5, 6-9, 10-13 and 14-17 years ages. The group means and standard deviations were determined for various risk factors and comparisons were made using over all means of all groups. The comparisons were made using a two tailed students t test with $P < 0.05$ as the significant level. The prevalence rates of abnormally high RFs were determined by using the upper limits of US data i.e., >95th percentile for blood pressure, height and weight and 90th percentile for serum cholesterol.

Only base line data of MHS was used and only RF data of 5-17 year old children was included. All persons 18 years or older were excluded.

Table 1. Risk factors profile in Pakistani boys and girls aged 5-17 years in the MHS.

Sex	Age		Height (cm)	Weight (kg)	BMI (kg/m^2)	WHR (waist/hip)	SBP/DBP (mmHg)	Cholesterol (mg/dL)
Boys	5	N	38	38	38	39	38/38	32
		Mean	108	16	14.0	0.93	93/67	123
		SD	9.35	2.8	1.6	0.06	7.2/8.9	24.2
	6-9	N	125	125	125	127	122/122	117
		Mean	122	21	14.2	0.90	95/69	121
		SD	8.72	4.2	1.8	0.10	8.7/9.9	21.6
	10-13	N	144	144	144	145	141/140	141
		Mean	144	33	15.5	0.85	99/72	132
		SD	11.6	9.9	2.7	0.07	8.7/10.3	31.3
	14-17	N	105	105	105	104	105/104	101
		Mean	167	50	17.8	0.83	109/77	129
		SD	10.2	12.4	3.1	0.08	10.9/9.2	23.8
	All	N	412	412	412	417	405/404	391
		Mean	140	32	15.6	0.87	100/72	127
		SD	22.3	15.0	2.9	0.09	10.8/10.4	26.6
Girls	5	N	28	28	28	31	31/31	29
		Mean	107	16	14.4	0.92	93/67	123
		SD	7.0	2.9	1.9	0.05	7.8/7.9	26.7
	6-9	N	147	147	147	148	144/144	138
		Mean	121	21	14.2	0.87	98/70	127
		SD	11.0	5.1	2.3	0.06	10.4/9.7	26.2
	10-13	N	120	120	120	123	121/119	118
		Mean	142	32	15.7	0.80	103/72	134
		SD	11.9	8.8	2.6	0.05	9.6/8.3	31.8
	14-17	N	87	87	87	87	85/84	84
		Mean	156	47	19.2	0.77	109/75	138
		SD	7.0	11.2	3.9	0.07	10.6/10.7	25.3
	All	N	382	382	382	389	381/371	369
		Mean	135	30	15.8	0.83	102/71	131
		SD	18.9	13.2	3.4	0.08	11.1/9.7	28.3

Table 2. Risk factors profile in Pakistani boys and girls aged 5-17 years in the PMRC.

Sex	Age		Height (cm)	Weight (kg)	BMI (kg/m2)	WHR (waist/hip)	SBP/DBP (mmHg)	Cholesterol (mg/dL)
Boys	5	N	262	262	262	-	260/259	-
		Mean	105	16	14.4	-	94/60	-
		SD	7.4	3.1	2.6	-	9.6/9.0	-
	6-9	N	994	994	994	-	1032/1031	-
		Mean	120	20	14.1	-	99/64	-
		SD	9.1	4.0	1.6	-	9.5/8.5	-
	10-13	N	780	780	780	-	807/804	-
		Mean	140	30	15.2	-	104/68	-
		SD	10.5	7.1	2.1	-	10.0/8.5	-
	14-17	N	561	561	561	386	570/565	367
		Mean	162	47	17.6	0.84	113/74	129
		SD	9.4	9.7	2.7	0.05	11.3/9.3	25.4
	All	N	2597	2597	2597	386	2669/2659	367
		Mean	134	29	15.2	0.84	103/67	129
		SD	20.8	12.5	2.5	0.05	11.7/9.8	25.4
Girls	5	N	228	228	228	-	219/218	-
		Mean	104	15	14.4	-	88/53	-
		SD	8.6	2.4	4.5	-	9.5/9.3	-
	6-9	N	930	930	930	-	928/921	-
		Mean	120	20	14.0	-	94/57	-
		SD	10.4	4.5	1.5	-	10.0/9.7	-
	10-13	N	701	701	701	-	707/699	-
		Mean	141	31	15.6	-	102/62	-
		SD	10.3	7.9	2.4	-	11.4/8.4	-
	14-17	N	539	539	539	392	541/538	382
		Mean	153	44	18.8	0.85	111/70	140
		SD	6.2	7.5	2.9	0.08	11.4/8.5	29.0
	All	N	2398	2398	2398	392	2395/2376	382
		Mean	132	28	15.6	0.85	100/61	140
		SD	18.6	11.8	3.1	0.08	13.0/10.7	29.0

Results

Risk factor profiles of MHS and PMRC children aged 5-17 years included data on height, weight, BMI, waist-hip ratio, blood pressure and cholesterol. Means and standard deviations of these variables are shown in Table 1 for MHS boys and girls and in Table 2 for PMRC boys and girls.

Table 3. The overall mean risk factors in 5-17 years US children (NHANES-III).

Sex		Height (cm)	Weight (kg)	BMI (kg/m^2)	SBP/DBP (mmHg)	Cholesterol (mg/dL)
Boys	Mean	138.4	39.21	18.77	102/55.6	154.1
	SD	48.0	41.8	9.16	23.6/22.7	42.2
	N	5003	5038	4970	3167/2659	694
Girls	Mean	135.6	37.5	18.93	100.1/54.9	169.2*
	SD	64.8	50.5	11.5	25.8/26.7	40.2
	N	5190	5214	5142	3302/2974	805

*Values of 14-17 years groups.

SBP = Systolic blood pressure

DBP = Diastolic blood pressure

Table 4. Prevalence of high risk factors[a] in PMRC and MHS children, age 5-17.

		Blood pressure (mmHg)			Cholesterol (mg/dL)			Weight (kg)		
		N	High BP	%	N	High cholesterol	%	N	Over-weight	%
Boys	PMRC	2715	14	5.3	367[b]	9	2.5	2597	13	0.5
	MHS	405	58	14.3	391	14	3.6	412	9	2.2
Girls	PMRC	2395	41	1.7	382[b]	25	6.5	2398	8	0.3
	MHS	381	47	12.3	369	10	2.7	382	7	1.8
All	PMRC	5064	182	3.6	749[b]	34	4.5	4995	21	0.4
	MHS	786	105	13.4	760	24	3.2	794	16	2.0

a High BP = SBP or DBP greater than the 95th percentile of US BP.

High cholesterol = Cholesterol greater than the 90th percentile of US total cholesterol as shown in Tables 1-3, reference 19.

High weight = Weight greater than the 95th percentile of US weight. Reference 23.

b children 14-17 years of age only.

In the MHS sample (Table 1), boys were slightly taller than girls as expected, with the difference increasing with age. Mean height was about the same for boys and girls under 10 years of age. At 10 years mean height difference between boys and girls began to appear. At ages 14-17, mean height was 167 cm for boys and 156 cm for girls. Little difference was noted in mean weight between boys and girls as age increased. It is, therefore, not surprising that over all mean BMI was higher but not statistically significant ($P<0.31$) for girls than boys in the MHS sample. Mean waist-hip ratio was higher in boys ($P<0.000$) and declined with age in both sexes. There was little difference in mean systolic and diastolic blood pressure by sex. Mean total cholesterol was higher in girls than in boys in the MHS ($P<0.04$).

In the PMRC sample (Table 2), boys were generally taller than girls, weighed about the same on average and

Abbreviations: SBP = Systolic blood pressure (mmHg).
DBP = Diastolic blood pressure (mmHg), BMI = Body mass index (Kg/m^2).
SC = Serum cholesterol (mg/dl), Ht = Height (cm), Wt = Weight (Kg).

Figures (a) and (b).

Mean systolic blood pressures were higher in boys than girls in the PMRC sample (P<0.001). As compared to MHS data, mean systolic blood pressure was higher in the PMRC for boys (P<0.0000) and lower for girls (P<0.005). Mean diastolic blood pressure was lower in the PMRC than in the MHS for both sexes (P< 0.001). Total cholesterol and waist-hip ratio data were not available in the PMRC survey for ages under 14 years. For ages 14-17, total cholesterol was higher for girls than boys in both PMRC (P< 0.0000) and MHS girls than boys (P <0.046). Comparison of 14 - 17 year old boys and girls of MHS and PMRC showed no significant difference. Compared to PMRC, BMI was significantly higher in MHS boys (P <0.003) while no difference was present in girls. Compared to MHS Waist Hip ratio was not higher in PMRC boys and was significantly higher in girls (P< 0.001).

BMI in the US NHANES 111data[17] (Table 3) had significantly lower values for MHS and PMRC for both boys and girls (P<0.001) and SBP in girls was higher though not significantly than in the NHANES111 data. SBP was lower in boys and diastolic pressure was higher in both boys and girls of both PMRC and MHS (P<0.001). The SBP in PMRC boys was higher than US (P= 0.046). Mean serum cholesterol was significantly lower in both boys and girls of MHS and 14- 17 year age groups for which data was available, with similar age group of NHANES111 (P<0.001). PMRC boys and girls were smaller (P<0.001 and P=0.076 respectively) and their weight was also significantly less than US children (P<0.001) (Figures (a,b). The boys and girls in MHS were of same height as US.

The incidence of hypertension in the MHS was determined by using the 95th percentile values of the US Task Force data of 5-17 year old boys and girls.[16] As shown in Table 3, there were 405 boys and 381 girls and 58 (14.3%) of the boys and 47 (12.3%) of the girls exceeded the Task Force data limits, implying that hypertension was present in 13.4% of total children in Metroville. Total serum cholesterol exceeding the 90th percentile in the US data[18] was noted in 14 of 391 boys (3.6%) and 10 of 369 girls (2.7%). The overall incidence of hypercholesterolemia was present in 3.2% of children in the MHS. Based on normal US data[19] obesity or the percent overweight (exceeding the 95th percentile of US weight limits) was present in 9 of 412 boys (2.2%) and 7 of 382 girls (1.8%).[20]

PMRC data (Table 3) showed that high blood pressure was present in 5.3% of boys and 1.7% of girls, with the overall incidence of hypertension in children aged 5-17 years of 3.6%. Hypercholesterolemia was present in 2.5% of boys aged 14-17 years and 6.5% of girls aged 14-17 years, with the overall incidence in that age group of 4.5%. Overweight was noted in 0.5% of boys and 0.3% of girls in the PMRC. Serum cholesterol levels only in children aged 14-17 years were compared because cholesterol was not determined in children less than 14 years of age in the PMRC.

Comparing MHS data with PMRC data, it is evident that hypertension was more prevalent in the MHS for both sexes, and was more prevalent in boys than girls (P<0.001) (Table 4). Cholesterol and waist-hip ratio cannot be compared between the two surveys because the PMRC did not collect these data over the entire age range. Obesity was more prevalent in the MHS boys as well as girls (P<0.0007 and in both MHS and PMRC it was higher in girls (P<0.001). Less than 1% boys and girls smoked.

Discussion

Through the analysis of data collected by the PMRC as part of the Pakistan National Health Survey, we have defined the RF profile of children aged 5-17 years. The overall mean height, weight, BMI, serum cholesterol, systolic and diastolic blood pressure and waist-hip ratio have been determined for most sub-groups in the 5-17 age range. These data we believe should be helpful in determining the determining the risks for CHD in Pakistan. Furthermore, it allows the comparative assessment of Pakistan risk factor profiles with those of other countries. When comparing Pakistan's cardiovascular RF profile with US children, the profile was lower for BMI in Pakistani children at all ages. The diastolic blood pressure was higher for Pakistani girls and boys than US girls and lower for Pakistani boys than US boys. Serum cholesterol was lower for both Pakistan sexes and smoking was much lower in Pakistani children than in US children. This comparison of RF with a highly affluent country such as the US where CHD is exceedingly common, suggests a possible degree of protection from future CHD in countries with lower affluence levels, such as Pakistan. Economic development in Pakistan is sure to change the risk factor profile of children if Pakistan pursues the road to affluence that the US took. Our study demonstrates that the newly emerging urban community had worst RF profile than the National average. At the present time, obesity in Pakistani children is insignificant; hypercholesterolemia is not at alarming levels, and smoking remains at low levels. These are controllable factors. As the economic and buying power of Pakistani children improve, dietary intake must be closely monitored with a close watch on changes from saturated to unsaturated fats, and on smoking and blood pressure changes. Education regarding CHD and its prevention must be taught to young children in school. The RF data thus allows one to plan and develop appropriate preventive strategies.

Comparison of the RF profile of Metroville with the national average showed that urban children were heavier and taller than the national average. SBP and serum cholesterol were similar, while DBP was higher than the national average in MHS girls and boys. Prevalence data of RF in the MHS and PMRC data showed that hypertension and obesity were much more prevalent in the MHS and prevalence rates of high serum cholesterol levels of the MHS 14-17 year old boys and girls were significantly higher than the national prevalence rate. These differences suggest that the communities in Pakistan are not homogenous regarding nutrition and demography, and many of the communities are either very poor or affluent. This bimodal distribution of the demographic profile is also apparent in the date of Pakistan Health Survey.[2] This has led to the development of Pakistani children's weight and nutrition normality standards separately for the economically privileged and economically depressed communities.[20] Furthermore, since the economically poor communities are predominant, the national RF profiles reflect conditions in the poor areas and are less reflective of the RF profile of middle or affluent communities. It is thus imperative that a community profile of RF be determined before planning for RF modification so that dominant risk factors are modified in preference to others not so prevalent in a community. For instance, in Metroville, hypertension was the most prevalent RF and, therefore, RF modification would need to be concentrated on salt reduction in diets of children and, for hypercholesterolemia, efforts would have to be directed to reducing consumption of Ghee (saturated form of fat) and substitution with unsaturated oils. In spite of low average RF profile of Pakistani children, the incidence of CHD in urban adults is increasing in Pakistan[21] and the reason may be that the RF profile in adults is becoming similar to that of affluent countries because, along with economic prosperity, education for prevention of CHD has not been provided. Our comparative data of RF with the US suggest that we need to maintain the low RF profile of childhood by instituting risk modification early so that CHD in adults can be controlled. Our study shows that hypertension has emerged as the major RF in Pakistani children and adults at a rate twice that of affluent countries. The increased salt usage, lack of physical education programs in schools and malnutrition of mother giving birth to low birth weight babies[22] are some of factors contributing to increased prevalence of hypertension and prevention of these is the key to control future CHD. This may sound simple but in a country as Pakistan, where food is cooked with salt and Ghee, a major intervention may be required.

Our data demonstrates that lower middle class communities are the ones at greatest risk for future CHD because, these communities have higher RF than the national average, determined by the results of the National Survey. There is increasing economic development in Pakistan which confers increasing purchasing power and as higher education is improving, therefore, life style changes are likely to occur in the near future. Our data suggests that education regarding prevention of CHD needs to be applied in these newly emerging urban lower middle class communities on a priority basis, if we are to achieve success in preventing CHD in adults.

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